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Rethinking farmers' intended risk behaviour:
The role of risk perception, risk attitude and decision context

Thesis submitted in the fulfilment of the requirements
for the degree of Doctor (PhD) of Applied Biological Sciences

This research was funded by the Agency for Innovation by Science and Technology (IWT)

Dutch translation of the title:
Het intentionele risicogedrag van landbouwers heroverwogen:
De rol van risicoperceptie, risicohouding en beslissingscontext

Suggested way of citation:
van Winsen, F. 2014. Rethinking farmers' intended risk behaviour: The role of risk perception, risk attitude and decision context. Doctoral dissertation, Ghent University

ISBN: 978-90-5989-741-0

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Acknowledgments

I am grateful for all the support I received throughout the process of writing this dissertation. Although I cannot acknowledge everybody that supported me by name, I would like to mention a few people who I am especially indebted to.

Als eerste wil ik mijn promotoren Prof. Ludwig Lauwers en Prof. Erwin Wauters bedanken. Ludwig, bedankt om mij de kans te geven om dit proefschrift te starten en voor het vertrouwen dat ik vanaf het begin heb mogen ervaren. Erwin, bedankt om mij wegwijs te maken in de landbouweconomie. Door jullie pragmatische aanpak bleef ik op koers en kon het onderzoek voor dit proefschrift steeds verder evolueren.

Tijdens mijn tijd als doctoraatstudent heb ik mogen werken aan een onderzoeks-project. Graag zou ik de leden van de project stuurgroep Prof. Steven Van Passel en Prof. Mark Vancauteren willen bedanken voor de aanwijzingen en adviezen die ik van hen heb mogen ontvangen. Speciaal wil ik hier Dr. Yann de Mey bedanken voor een fijne samenwerking. Mijn dank gaat ook uit naar alle personen en organisaties die in de gebruikerscommissie zetelden en de overige projectpartners: Afdeling Landbouw- en Visserijbeleid en Afdeling Monitoring en Studie van het Departement Landbouw en Visserij, Crelan, CCAB, Boerenbond, Vlaams Agrarisch Centrum, Boeren op een Kruispunt, Liba en de Vlaamse Landmaatschappij. Bovendien wil ik IWT bedanken voor de financiële steun.

I also would like to express my gratitude for the valuable and constructive comments of the members of the examination board that served to significantly improve my dissertation.

Hierbij ook een woord van dank aan al mijn collega's en ex-collega's op ILVO L&M. L&M biedt een inspirerende werkomgeving voor de uitwisseling van onderzoeks-vaardigheden en technieken, maar ook van nieuwe en verfrissende ideeën. Fleur en Koen, bedankt voor jullie opvolging en adviezen tijdens de begeleidingscommissies.

Roel bedankt om tot het laatste moment mijn werk kritisch na te lezen. Merci Virginie de m'avoir soutenu tout au long de cette thèse, depuis le moment où tu m'as fait remarquer cette opportunité de doctorat à l'ILVO, jusqu'à la dernière relecture de mon manuscrit.

Als laatste, maar zeker niet als minste, ben ik mijn dank verschuldigd aan alle landbouwers die hebben meegewerkt aan de totstandkoming van dit proefschrift, door interviews te geven, enquêtes in te vullen of gewoon eens te vertellen over hun visie op het risico in de landbouw.

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List of abbreviations

CAP	=	Common Agricultural Policy of the European Union
CFA	=	Confirmatory Factor Analysis
CFI	=	Comparative Fit Index
CMIN	=	MINimum value of the discrepancy
COV	=	Coefficient Of Variation
CRRA	=	Constant Relative Risk Aversion
Df	=	Degrees of Freedom
EHEC	=	Entero Hemorragische Escherichia Coli
EFA	=	Exploratory Factor Analysis
EU	=	the European Union
EUT	=	Expected Utility Theory
ESU	=	Economic Standard Unit
FADN	=	Farmers' Accountancy Data Network
FAO	=	Food and Agriculture Organization of the United Nations
GFI	=	Goodness of Fit Index
HHI	=	Herfindahl-Hirchman Index
HRB	=	Household Risk Balancing
KMO-test	=	Kaiser-Meyer-Olkin test
MPL	=	Multiple Price List
OECD	=	Organisation for Economic Co-operation and Development
NOI	=	Net Operating Income
PCA	=	Principle Component Analysis
RTA	=	Return on Total Assets
RMR	=	Root Mean square Residual
RMSEA	=	Root Mean Square Error of Approximation
SEM	=	Structural Equation Model
SEU	=	Subjected Expected Utility
SO	=	Standard Output
SUR	=	Seemingly Unrelated Regression
SUEST	=	Seemingly Unrelated ESTimator
US	=	United States of America
VIF	=	Variance Inflation Factors

Chapter 1

Introduction

Risk has always been crucial in farming and recent developments have reinforced this importance. Consequently, coping with risk by applying the appropriate risk management strategies on and off the farm is increasingly pertinent. Farmers' behaviour under risk is amongst other disciplines investigated in agricultural economics. The understanding of how farmers conceptualise and cope with risk in this discipline is embedded in a rationality paradigm and based on a probabilistic understanding of risk. However, methods rooted in this rationality paradigm, particularly those based on expected utility theory, fail to accurately predict actual behaviour of farmers under risk. This doctoral dissertation combines a collection of individual papers, each constituting an explorative investigation in the actual understanding of the manner in which farmers cope with risk. A key assumption is that both perceptions of risk and attitudes towards risk need to be considered for understanding intended behaviour under risk. This dissertation is divided into two parts that differ from each other in their approach towards risk. The first part investigates general perceived risks, risk attitude and their relation to the intended use of common risk management strategies, taking a rather classical probabilistic approach towards risk. The second part departs from this classical approach and investigates risk as actually perceived by farmers and the validity of risk attitude in context.

1.1 Background: Risk and risk management in farming

1.1.1 A definition of risk

Considering that risk is commonplace, it is remarkable that there seems to be no consensus about the definition of risk (Renn, 1998a; Hansson, 1996; Thompson and Dean, 1996; Yates and Stone, 1992; Fischhoff et al., 1984). As such, the very fact of communicating about risk is risky in itself, or according to Renn (1998b, p. 50): *"Speaking about risk faces the immediate danger that everybody understands something different"*. Much of the controversy can be brought back to two debates concerning: i) the epistemological foundation of risk, and ii) the distinction between risk and uncertainty.

Different views on risk can be grouped according to their epistemological foundations (Hermansson, 2012; Zinn, 2008). Constructivists argue that risk does not objectively exist (Sjöberg et al., 2004). Risk, or uncertainty of any kind, is characterised by a lack of information. Risk and uncertainty do not exist if the decision maker has perfect information about the consequences of his choice (Windschitl and Wells, 1996). According to purist constructivism, risk is a construct formed by society and is based on historical, sociological and political conditions. Hence, within a constructivist epistemology, risk cannot be objectively measured (Lupton, 1999). Some constructionists also accept a weaker epistemology on risk, conceptualising risk as an objective event that is nonetheless inseparable from social and cultural processes (Lupton, 1999).

From a realist perspective, risk is seen as a real event or real threat and is objectively measurable (Zinn, 2008). Risk in this view is seen as the multiplication of the probability of the risk event happening and the negative (or positive) impact of the risk. When the factors "impact" and "probability" are uncertain, this is ascribed to a lack of knowledge. Hence, further research into the topic may lead to greater precision of the risk (Zinn, 2008). From a realist perspective, risk is seen as objective and calculable. Nonetheless, this approach leaves room for risk being subjectively biased by personal interpretation. In this dissertation a realist approach towards risk is taken, while, at the same time, a main premise of this dissertation is that individuals base their decisions on their personal perceptions of risk rather than on 'objective' risk.

Another controversy in the concept of risk is related to the definition and distinction of risk and uncertainty. Risk is intrinsically linked to uncertainty (Aven, 2010a) and both concepts are often defined in association with each other (Hansson, 1999; Leroy and Singell, 1987). Knight (1921) defines risk as a situation with more than one possible outcome for which the (exact) probabilities are known, whereas for uncertainty these probabilities are not known. Many studies on decision making under risk are built on this distinction (Leroy and Singell, 1987). However, situations with known probabilities are rare (Aven, 2010b; Hardaker et al., 2004) and practically excluded to exceptional, textbook, cases such as lottery experiments (Hansson, 1999). Risk can also be distinguished from uncertainty based on whether there are stakes involved, or according to Gough (1988, p. 9): "… *uncertainty does*

not imply risk if there are no direct consequences to the individual or decision maker". Hardaker et al. (2004) define uncertainty as imperfect knowledge and risk as uncertain consequences. As such, uncertainty is value free, whereas risk involves preferences for outcomes (Hardaker et al., 2004). Harwood et al. (1999, p. 2), define risk in line with this definition as "*uncertainty that matters*" and "*uncertainty that affects an individual's welfare*". Hence, uncertainty is a necessity for risk, but does not always imply or lead to risk. The Society for Risk Analysis defines risk as (Boholm and Corvellec, 2011, p. 177): "*… the potential for realization of unwanted, adverse consequences to human life, health, property, or the environment*". Hence, only uncertainty that brings a potential unwanted or negative consequence is considered as risk. In this dissertation this definition is adhered to, and risk defined as: uncertainty that affects in possible gains but also in possible losses.

1.1.2 Risk in farming

Farming is inherently a risky business (Ogurtsov et al., 2008). To give an overview of the wide variety of risk faced by a farmer, it is useful to categorise the major sources of risk. Hardaker et al. (2004) divide the major sources of risks in: production risk, price or market risk, institutional risk, personal risk and financial risk.

Production risk is the risk that is inherent to uncertainties related to the production on the farm. One thing that sets farmers apart from other producers is that they work with living organisms that are vulnerable to their environments and diseases. Crops are typically grown outside, exposed to the elements. Hence, drought, floods, hail, storms, extreme temperatures and other abiotic stresses are one of the biggest threats to crop production (Gommes, 1993). Furthermore, pests, pathogens, viruses and weeds cause an annual global loss of the six major crops (wheat, rice, maize, potatoes, soybeans and cotton) of 25% to 40% (Oerke, 2005). Livestock farmers face a different production risk, since livestock is mostly kept in whole or partial confinement, which reduces the exposure to extreme weather conditions and diseases (OECD, 2009). Conversely, confinement implies that the animals live in close proximity to each other, facilitating the dissemination of disease and epidemics (Gilchrist et al., 2007). Furthermore, governments can enforce large scale pre-emptive culling of healthy animals in order to avoid propagation of infectious diseases (Meijboom et al., 2009; Burrell, 2002). As such, production risk for livestock tends to be infrequent but with high impact to the farm (Gramig et al., 2006).

Additionally, epidemics can fuel speculations about food safety, possibly triggering a drop in demand, leading to temporary trade restrictions and resulting in lower prices (OECD, 2009; Morgan and Prakash, 2006). In general, agricultural food supply and demand are very inelastic, causing prices to be volatile (Gilbert and Morgan, 2010). Output prices can change considerably in the period between initial investment and the time that products can be sold, i.e. the biological time lag (OECD, 2009). Furthermore, agricultural products, especially fresh fruits and vegetables, cannot be stored for longer time periods, for example, the time it takes waiting for prices to be right (OECD, 2009). Additionally, most farm products are

commodities, i.e. the same types of farm products are indistinguishable from and interchangeable with each other. These factors, amongst others (e.g. the large number of producers compared to the smaller number of buyers), force farmers in a price-takers position (Ascari, 2003). The risk that is caused by uncertain and unstable prices (both input and output prices) is referred to as price or market risk (Hardaker et al., 2004).

Institutional risk is the risk that is due to uncertainty about formal rules and regulations that affect farming (Hardaker et al., 2004). While agricultural policies are normally aimed to assist farmers, they can also be a source of risk (OECD, 2009). For example, farmers need to adhere to certain rules regarding food safety and environmental regulations and their compliance is subsequently inspected. New regulation often imposes costs on farming (Gardner and Steinberg, 2005). Furthermore, the subsidies that farmers often receive may be revoked due to changes in regulation and policy (OECD, 2009).

Farms in Europe, and Belgium specifically, are predominantly family owned. These farms typically depend almost solely on the farmer and his or her partner, sometimes aided by an externally employed workforce. If the farm manager or the partner becomes incapacitated due to an accident, illness, divorce or any other reason, this will impact the management of the farm. This type of risk is referred to as personal risk (Hardaker et al., 2004).

The above mentioned risks are all affecting the operation of the farm and, as such, are collectively referred to as business risk. Business risk is independent of the financial situation of the farm. Farming requires large investment in amongst others, land, buildings and machinery. In particular, young farmers are typically confronted with large debts and associated substantial financial obligations. It is not always certain whether the annual payments can be met. The risk associated with the farm's financial situation is referred to as financial risk (Hardaker et al., 2004).

1.1.3 The increasing pertinence of risk in farming

Risk has always been an important factor in farming, recent developments and longer term gradual changes have changed the diversity, incidence and significance of risk in farming (Urry, 2005). Gradual changes include climate change, an increasing awareness and demand for environmental and social sustainability of farms, globalization and increasingly competitive market environments.

Given that crop productivity is mainly driven by technology and agronomic improvements, it is unlikely that global climate change will cause a global decline of crop production in the next 50 years (Lobell and Gourdji, 2012). However, crop production could locally become more risky due to increasingly frequent extreme climatic conditions such as droughts, floods or storms (Olesen and Bindi, 2002). Furthermore, it is expected that climate change impacts livestock both indirectly, affecting the grasslands, and directly, through decreased water availability and increased heat stress (Thornton et al., 2009). Additionally, climate change could

cause an increase in vector borne diseases among livestock (Thornton and Cramer, 2012). Hence, climate change might not affect average global production, however locally production is expected to become more volatile and risky (Lobell and Gourdji, 2012).

Societal awareness of global climate change has developed substantively in the last decades (Lorenzoni and Pidgeon, 2006), which coincides with an increasing awareness of environmental and animal welfare concerns (Harper and Makatouni, 2002). These developments place an increasing pressure on farmers to farm "greener", i.e. restricting the use of possible harmful inputs and choosing environmental and animal friendly production methods (Brouwer, 2012). Formal policy measures at the regional and national level, as well as the Common Agricultural Policy (CAP) of the European Union (EU), are following a similar trend of promoting environmentally friendly practices through strict regulation and support measures such as agri-environmental schemes (e.g. Matthews, 2013).

Since two decades, policies have shifted away from a policy of direct income stabilization to a policy that puts the responsibility for risk management in the hands of the farmers through the use of market-based risk management tools (Varangis et al., 2002). Over the years, this has resulted, for example, in a policy of income support that moves away from coupled payments (Beard and Swinbank, 2001). These changes coincide with an increasingly globalized market. Although the globalization and liberalization of markets have the potential to reduce volatility, the decrease in governmental induced stabilization processes often initially increases the volatility of these markets (OECD, 2009). Indeed, the volatility of both output and input prices is expected to initially increase due to globalization, liberalisation and increased trade levels (Ericksen et al., 2009; Sumner, 2009; Chavas and Kim, 2006; Eakin, 2005; European Commission, 2001). At the same time, the gap between market prices and cost prices is decreasing, leading to smaller margins or a 'profit squeeze' (e.g. Himics et al., 2012). These changes co-occurred with changes at the farm level, such as modernisation, specialisation and scale enlargement (Antrop, 2005). As farmers are consequently working on a decreasing number of farms of increasing size, risk will possibly have a greater impact on the farm business and the financial situation of the farm family.

1.1.4 Risk management in farming

Farmers' risk management is generally either one of three types: risk reduction, risk mitigation or risk coping (OECD, 2009). Risk reduction involves any measure to decrease the probability that adverse events hit the farm, such as technological choice or the use of forward contracts. Risk mitigation is done by strategies that allow the risk to happen, but reduce its impact, such as obtaining an off-farm income, internal strategies like diversification, or market based strategies, such as insurances. Risk coping, thirdly, is performed using strategies that restore (part of) the damage after it happens, such as cutting private expenses or selling assets.

Farmers' risk management is about choosing the right tools and strategies to cope with the uncertainties inherent to farming. Farmers have managed risk throughout

history. In fact, the origin of farming can be seen in itself as a reaction to the increasingly uncertain hunter-gatherer lifestyle during the Neolithic revolution (Price and Bar-Yosef, 2011). As population increased and game became scarcer (e.g. Smith, 1975), hunting became an increasingly risky undertaking and growing crops and herding livestock was the safer option (Cohen, 1979; North and Thomas, 1977). Since then, agriculture has evolved as a continuous struggle to manage the ever present risk inherent to cultivating food: breeding and cultivating plants and animals, using irrigation and erosion control, and implementing numerous other risk management strategies.

Nowadays, risk management has a central role in farm management. Farm risk management strategies or tools can target a specific risk. For example, the extent to which epidemics and diseases are a risk for livestock depends largely on the farm (risk) management of the farmer (Meuwissen et al., 2005), such as hygiene and vaccination. The risk of diseases in plants can be minimized by using pesticides. Climatic variations can be stabilized in greenhouses and irrigation can prevent crop losses from drought. Additionally, insurances can protect the farmer against the impact of a wide range of production losses. Other instruments specifically targeting price risks and market risks include, but are not limited to, minimal price contracts, forward contracts and future markets. Besides these risk management tools that target specific risks, farmers use more general risk management tools and strategies such as diversification of both production and income, obtaining an off-farm income, avoiding loans and maintaining financial buffers.

With the increasing pertinence of risk, risk management becomes more important for maintaining a viable business. The understanding of how farmers make decisions, which is this doctoral dissertation's central concern, is therefore increasingly relevant.

1.2 The gap between the literature on decision making under risk and farmer's actual coping with risk

1.2.1 The traditional agricultural economic understanding of risk

For the last decades, the dominant focus in farming was on increasing productivity and efficiency (Sayer and Cassman, 2013; Lamine, 2011; Lyson and Guptill, 2004; Beus and Dunlap, 1990). Food production has successfully been driven to unprecedented levels of efficiency, by technical innovation (Godfray et al., 2010; Tilman et al., 2002; Khush, 2001) and modernisation and specialisation of farms (Milestad et al., 2012; Purdy, 1997). The focus was, and still is, on maximizing output per unit of input and creating the optimal conditions to do so. This entails stabilizing internal and external production factors, whereas fluctuations are counterproductive to the goal of optimizing outputs per unit of input (Darnhofer et al., 2010) Policy measures have, in line with this focus, contributed to stabilizing environmental factors (Jay, 2007; Walford, 2002; Tweeten and Zalauf, 1997).

Income stabilisation schemes and subsidies have been crucial to the success of the efficiency levels that can be observed today (Stiglitz, 1987).

In such an efficiency-based model, where controlling the external environment is key, there is a need for methods that can identify and quantify the various risks. The manner in which farmers ought to cope with these risks can then be prescribed, considering the farmers' personal preferences for taking or avoiding risks. As risk in the agricultural economic literature has been predominantly studied with this efficiency model in mind (Sayer and Cassman, 2013; Milestad et al., 2012), methods in agricultural economy are often shaped by the associated logical and positivist thinking (van den Bergh et al., 2000). Particularly, Expected Utility Theory (EUT) has been dominating studies investigating the behaviour of farmers confronted with risk (Hardaker and Lien, 2010; Grüne-Yanoff, 2007; Hastie, 2001; Sarin and Weber, 1993). These approaches assume that decision makers act as well-informed rational agents that are able to optimise their (monetary) self-interests (For an overview of EUT and other rational approaches to decision making under risk see section 1.4.1).

1.2.2 New insights about risk

In the last decades, we have seen a growing awareness of the environmental and social consequences of economic growth (Jackson, 2009; Munasinghe, 1999). Even growth as a goal in itself has been questioned (McKibben, 2007). Farming is pre-eminently a vocation that is seen as a lifestyle rather than just a profession (Herrmann and Uttitz, 1990). As such, other goals, like sufficient production levels combined with a reasonable workload and environmental and social consciousness, are moving the focus away from sheer economic gain (Nielsen, 2009). With this changing view, there is a need for revising the way risk is regarded in the agricultural economic literature.

Indeed, there is an increasing awareness in the agricultural economic literature that traditional EUT-based approaches are limited in their scope (Shaw and Woodward, 2008; Rottenstreich and Kivetz, 2006; Buschena, 2003; e.g. Bard and Barry, 2001; Starmer, 2000; Jones, 1999; Woodward, 1998; Backus et al., 1997; Harless and Camerer, 1994). The use of EUT has limited the agriculture economic literature to focus on risks that are quantifiable and for which numeric data is easily available (Hardaker and Lien, 2010). This focus and overrepresentation of quantifiable economic concerns has been described as too narrow (Willock et al., 1999a), especially since the multiple and conflicting goals of farmers cannot be incorporated in these models (Darnhofer et al., 2012; Byron, 2005).

EUT provides a normative model for (optimal) decision making that prescribes how rational decision makers ought to choose (Starmer, 2000). However, the use of EUT for descriptive purposes is contended (Starmer, 2000). Only in simple situations, where decision makers have a clear and single operational objective and the decision environment is straightforward, the assumptions of rationality might hold (Simon, 1959). However, in more complex situations the assumptions of these models of rationality are insufficient and the need arises to better understand the

actual principles of the decision maker (Jones, 1999). As such, EUT fails to satisfactorily predict actual behaviour in complex environments such as farming. Indeed, a large body of literature proves that the behaviour of decision makers systemically differentiates from that predicted by EUT (see section 1.4.2). In the words of Jones (1999, p. 305): "*Even defenders of choice theory have retreated in the face of the onslaught of empirical findings. Expected-utility theory is no longer seriously entertained as an accurate descriptive theory"*.

EUT is based on the assumptions that risk behaviour can be predicted by establishing a person's attitude towards risk (see section 1.4). Although risk attitude is believed to be of major influence on risk behaviour (Chavas et al., 2010), the predicting power of risk attitude measures on actual farming behaviour has proven to be very low (Hellerstein et al., 2013). On the other hand, it is found that, particular in a complex decision environment such as farming, it is pertinent to apprehend risk perception in order to understand intended behaviour (Sjöberg et al., 2004; Sjöberg, 2000a; Weinstein, 1999; Wilson et al., 1993). Indeed, several studies show that differences in risk behaviour can be attributed by different perceptions rather than different attitudes (Weber, 1997; Weber and Milliman, 1997). Yet, risk perception is not explicitly taken into account in traditional EUT based approaches (see section 1.5). This observation, that risk perception should be more explicitly included in order to predict real life risk taking, is elegantly summarized by Milestad et al. (2012, p. 368): "*Within a command-and-control approach, the farm is conceived as a mechanistic system which can be fine-tuned and optimized. This is done best under laboratory conditions, where conditions can be neatly controlled. However, real-life farms are much more diverse than conceptualized, are driven by more complex interactions than assumed in the laboratory, and what is best depends for a large part on the perception of farmers.*".

In summary, studies taking an EUT approach have made significant contributions to our understanding of decision making; however, they often fail to adequately capture actual behaviour. In the words of Willock et al. (1999b, p. 287): "*Thus, the decision-making process of farmers does not easily lend itself to be modelled by the mathematical methods traditionally used by agricultural economists. However, the need to understand and model the processes and consequences of farmers' decision making remains.*"

1.3 Aims and outline of this dissertation

1.3.1 Research aims

This dissertation presents an explorative investigation in the manner in which farmers actually cope with risks. It aims to empirically contribute to the agricultural economic literature in providing a better understanding of farmers' actual perceptions of risk and attitudes towards risk, as well as insight into the question how these perceptions and attitudes interact to explain intended risk behaviours. An important premise in this dissertation is that to understand intended risk behaviour, risk perceptions should take a more prominent role than it currently

receives in most agricultural economic studies. Farmers act upon the risk they perceive and base their actions on their attitude towards risk (see section 1.5). Furthermore, the role of the complexity of the decision context is investigated. Different studies explore how farmers' choices under uncertainty are determined, how risks are perceived, how attitudes towards risk can be understood and how context determines choice. Quantitative and qualitative methods are used in order to address the following two main research questions:

Research Question 1: How important is risk perception relative to risk attitude in guiding intended risk behaviour?

Research Question 2: How does the decision context influence the decision under risk?

In addition to the contributions to the agricultural economic literature, this dissertation further aims to contribute to the field of general risk research. Farming offers an interesting domain for investigating individuals' managerial risk behaviour. First, farmers are typically making their business decisions independently. Second, farming is an inherently risky profession. Third, farmers' goals are usually extending further than merely profit making, as farming is typically a profession that is valued for the lifestyle that it provides (Willock et al., 1999a). The generalized findings can thus be applicable to the general field of risk research.

Investigating actual risk perception and risk coping by farmers should refrain from the same rationale that hampers much of the current research. Alternative methods should thus be explored. There have been few newly developed alternatives for elucidating decision making (for an overview see section 1.4), most studies use methods developed in the 1970's and 1980's (Hardaker and Lien, 2010; Wilson et al., 1993). The lack of viable alternative approaches is hampering the attempts to investigate farmers' decision making under uncertainty in more realistic settings. As such, studies on risk are for a large part constrained by methodological issues (Just, 2003). The methodological aim of this dissertation is to explore risk coping by farmers using alternative methods and to demonstrate their potential. In addition to the scientific contributions, the increased understanding and development of novel methods can be of practical benefit for policymakers or extension agents that aim to improve farm risk management.

1.3.2 Scope and constraints

The leitmotiv in this doctoral dissertation is the understanding of the actual risk behaviour of farmers. Several scientific theories from within and outside the decision making literature and behavioural economics are employed in an attempt to investigate this theme. Below an overview is given of some of the boundaries of the research scope and the assumptions made in the studies presented in this dissertation.

Farmers are individual and independent decision makers

In this dissertation, decision makers are assumed to make decisions independently. This does not mean that they cannot be influenced by their peers (in Chapter 6 it is found that peer behaviour does influence farmer's risk decisions), though the social context is not explicitly regarded. As such, interactions between the decision maker and other decision makers, such as in game theory (Camerer, 1989), or the influence of social norms, such as in the theory of reasoned action (Ajzen and Fishbein, 1980) and the theory of planned behaviour (Ajzen, 1991), are not investigated.

Intended behaviour is investigated

This dissertation considers intended or stated risk behaviour rather than actual behaviour. This is a deliberate choice and is based on two main reasons. First, when faced with risk a variety of options and possible outcomes are available, while on hindsight only one choice is made. When investigating actual decision making only this one choice is visible, while when investigating intended behaviour the broad range of possibilities is included. Second, the step from intended to actual behaviour is influenced by factors that are not of this study's concern, such as the physical limitations of choice and perceived behavioural control (Ajzen, 1991). In Part I, intended risk behaviour is operationalised as the intended use of common risk management strategies. In Chapter 6, intended risk behaviour is operationalised as the stated choice to accept or manage risk in a series of vignette proposed in a factorial survey (see section 1.3.3).

The physical consequences of the decisions on the farm are not investigated.

Associated with the previous constraint, the actual impact of farmers' risk behaviour is not considered. Every decision about risk, whether to take risk or to manage it, has its consequences on the farm. These consequences are considered as long as the perceived hypothetical consequences play a role in the decision making. However actual physical outcomes of the decision and the impact on the farm are not considered.

Focus on risk management

The interrelation between risk management strategies and farm management not based on risk management is not considered. As such, the influence of striving to achieve other goals, or indeed any behaviour other than those intended with the idea to manage risk, are not investigated. Furthermore, the application of risk management strategies is assumed to be solely and directly driven by contemplations about risk.

1.3.3 Outline

This dissertation describes four years of investigation that progressively advanced, gaining new insights about actual risk coping along the way. In hindsight, this progress can be divided in two distinct parts that are logically succeeding each other. Part I takes a rather traditional probabilistic approach towards risk. Conversely, Part II departs from this classical approach and critically investigates the assumptions of these traditional models and presents alternative methods to

investigate risk. As this dissertation combines various individual papers that were written to be read independently, an overlap between the different Chapters is unavoidable. The outline of the Chapters that form the two different Parts is provided below.

Part I investigates the determinants of the perceived usefulness of different well-known farm-level risk management strategies for farmers in Flanders. Similar to other studies on risk, this is based on a probabilistic approach rooted in the psychometric paradigm. Perceptions of major sources of risk and general risk attitude are assumed to be central in explaining the intended use of these strategies. Perceived risk is operationalised as the multiplication of subjective probability and subjective impact, and risk attitude is measured assuming an innate general preference for (financial) risk taking. The risks and risk management strategies considered are generic in scope and context free. Chapter 2 presents an overview of the relative importance of the perceived sources of risk, the attitude towards risk and the considerations of several common risk management options. The objective of this Chapter is to gain insight in what risks are perceived by the farmers in Flanders as serious, what risks are of lesser concern to the farmers, what is the general attitude of farmers towards risk, and what strategies the farmers perceive as useful risk management strategies for their farms. The objective of Chapter 3 is to present and empirically test the conceptual model that analyses the intended use of the investigated risk strategies, as determined by the perception of the major farm risks and risk attitude. It is found that perceived sources of risk are not significantly related to the stated intended use of the risk strategies. Finally, Chapter 4 investigates the determinants of the individual strategies in more detail, acknowledging the finding of Chapter 3.

In Part I, it appears that perceptions of risks are, in contrast to the main premise taken in this dissertation (see section 1.4), not significantly related to intended risk behaviour. However, there are two main reasons to doubt the generalization of this finding. First, the investigated risk sources, attitude and managements strategies are all general, rather than explicit. Hence, there is no direct link between the investigated perceptions of risk and the proposed risk management strategies, that is, the match is not absolute. Second, the operationalisation of perceived risk as the multiplication of perceived probability of the occurrence of an event with its impact on the farm when it occurs is disputed. For example, cognitive neuro-science has demonstrated that humans have difficulties to think in probabilities (see section 1.4.2). In Part II, these considerations form the basis for investigating risk perception and coping in line with the actual understanding of risk by farmers.

Part II differs from Part I, by departing from the assumptions of the traditional probabilistic method. Perceptions of risk, and the role of risk attitude on choice under risk, are further investigated and contextualized. The observation, that prior assumptions made about risk are rarely investigated, is the starting point for the study described in Chapter 5. In this Chapter a grounded theory approach is taken to investigate risk perception as actually understood by farmers. In Chapter 6, the influence of specific risk perceptions and several different risk attitude measures on

choice under risk is investigated. In this Chapter, risk perception is specific to the choice under study and not a general perception as in Part I. Contrary to the finding is Chapter 3, in Chapter 6 it is found that risk perception is significantly related to the choice to accept or avoid risk, on the contrary risk attitude is not.

The concluding Chapter 7 provides a general discussion synthesising the lessons learned from the empirical Chapters. The different findings of the relative importance of risk perceptions and risk attitude in Part I and Part II are further discussed and related to the literature. Furthermore, the conceptual, empirical, methodological and empirical contributions of this dissertation are considered. Finally, the study's limitations and directions for future research are posed before coming to the general conclusions.

1.3.4 Data and methods

The studies presented in this dissertation are conducted using a variety of methods using data collected from various sources. In Part I, a sequential mixed methods approach is taken, in which initial interviews served as input for a survey, which is complemented by farm accountancy data. In Part II, methods that are less commonly used in the agricultural economic literature are employed. In each individual Chapter a detailed overview of the data and methods used is provided. However, in order to clarify the differences between the sometimes seemingly overlapping Chapters, an overview follows, which expands on the methodological differences between the Chapters.

Data

A first source of data consists of open interviews with farmers. In total 35 farmers were interviewed, which were selected through purposeful sampling (Coyne, 1997). A publicly available list of farmers was used and additional farmers were found by recommendation of their interviewed colleagues (snowball sampling). A total of 19 farmers were interviewed in the study on risk perception described in Chapter 5. All other interviews served solely as input for the standard paper survey used in Part I.

A paper survey serves as the second source of data in this dissertation. In April 2013, this survey was mailed to 759 farmers in Flanders. The sample selection for the survey was independent of the sample selection of the interviewed farmers. In May 2013, 624 surveys were recovered, resulting in an initial response rate of 82%. Initial data cleaning removed 10 surveys because they contained more than 25% of missing values. Hence, the final sample had 614 respondents, which amounts to an effective response rate of 81%. Chapter 2 provides the descriptive statistics of the survey.

The samples of the survey consist of all the farmers that are taking part in the local European Commission's Farm Accounting Data Network (FADN) program for the Flanders region. For these farmers accountancy data (e.g. farm level information on yield, variable and fixed costs, and prices) are collected according to the EU accounting guidelines (FADN, 2010). This data provides a third source of data used in this dissertation. The data available at the time of research consists of panel data

up to the year 2011. As a consequence, a time lag of two years exists between the survey data and the latest available accountancy data.

For the analysis in Chapter 3 and Chapter 4, the survey data was complemented with the local FADN accountancy data. This coupling of survey data to accountancy data with a two-year time lag resulted in the loss of an additional 22 farmers, who were not registered in the FADN at that time. In Chapter 3, the removal of cases with missing values in any of the variables used resulted in a final sample of 500 farmers. In Chapter 4, some accountancy variables were calculated over a range of 3 years, hence losing an additional 121 farmers that were not included in the FADN dataset over this three years period resulting in a final sample of 379 farmers

A final source of data comes from a factorial survey. This electronic survey was sent out to 423 farmers in December 2013. In total, 139 farmers from the first paper survey had indicated that they wanted to participate in a follow up survey. The other farmers were contacted via two different farming organizations. In March 2014, 139 surveys were retrieved, of which 56 from farmers that also participated in the survey described above. After removal of cases that could not be used, a final sample size of 94 famers was used in Chapter 6, indicating an effective response rate of 22%.

Methods

Chapter 3 uses Structural Equation Modelling (SEM) to test the conceptual framework that explains the intended use of the surveyed risk strategies as determined by perceptions of major risk and risk attitude. These latter two variables mediate the effect of three types of antecedent variables: socio-demographics, farming attitudes and perceived past exposure to risk. As such, this model is compatible with the Transactional Modelling of Behaviour (TM). TM is an alternative of the wider known Theory of Planned Behaviour (Ajzen, 1991) and its predecessor Theory of Reasoned Action (Ajzen and Fishbein, 1980). It explains behaviour as mediated by mediating variables, typically cognitive constructs, and antecedent variables, such as personality traits and environmental variables (Willock et al., 1999b). SEM provides a good method to test such multivariate models (Willock et al., 1999b). Furthermore, SEM allows clustering various survey items, indicating specific concrete attitudes, in latent factors describing general abstract attitudes (Kline, 2011).

Chapter 4 uses Seemingly Unrelated Regression (SUR) to further investigate the determinants of the individual (non-clustered) strategies. It is chosen not to work with latent factors in this study, since the Chapter's focus is on the specificity of the determinants for each of the individual strategies. SUR allows investigating the individual determinants of each strategy, while controlling for possible common factors that influence the adoption of risk management strategies in general. Furthermore, SUR allows the different endogenous variables not to be autonomous, indeed the decisions of the implementation of the various strategies are made by the same decision maker. Finally, SUR does not place restrictions on the exogenous or independent variables. This contrasts Simultaneous Equation Modelling, which

assumes autonomous endogenous variables and works with the restriction that the exogenous variables cannot be the exact same for all the equations. As such, it was opted to use a SUR model rather than a Simultaneous Equation Model in this Chapter.

Chapter 5 takes a grounded theory approach to investigate the actual perception of risk, moving away from the assumptions made in many contemporary studies into risk (including those presented in Part I of this dissertation). The results of this grounded theory approach explain that risks are perceived in networks of interconnected sources of risk and consequences. These networks are best elucidated and presented using cognitive mapping. Elaboration on grounded theory and cognitive mapping is provided in Chapter 5.

Chapter 6 presents the results of a factorial survey, which is a survey technique, similar to conjoint analysis or choice experiments, which allows for the investigation of the influence of a variety of variables on choices or judgements (Wallander, 2009). As such, it provides a multifactorial design with the random application of different dimensions and levels. Furthermore, compared to traditional surveys, factorial survey helps to control for social desirability biases and presents a strong methodology for theory testing (Wallander, 2009; Jasso, 2006).

1.4 An overview of relevant decision models

This section provides an overview of a selection of the more influential decision making theories and how they have evolved over time. This overview is far from complete and does not try to be so. For instance, all theories discussed below, share their view on behaviour being intentional, i.e. assuming a goal-directed decision maker (Nielsen, 2009). This is in contrast with theories that explain behaviour as not necessarily guided by an instrumental logic, such as in cultural theory (Nielsen, 2009; Douglas and Wildavsky, 1982). In this latter group of theories, behaviour is seen as guided by sense of identity and social and cultural norms (Nielsen, 2009; Oltedal et al., 2004; Sjöberg, 2000b; Douglas and Wildavsky, 1982). Given our assumption of independent decision makers (see section 1.3.2), these theories are excluded.

Most of the theories of choice under risk, described below, are designed with lottery experiments in mind, for instance, assuming that the outcomes of the risk under study and their associated probabilities are known (van den Bergh et al., 2000). The inventory of outcomes with associated probabilities is commonly referred to as prospects (Starmer, 2000), and here the term is used accordingly.

First, the economic, rationality based, theories of choice, among which EUT is prime, are discussed. Thereafter, some shortcomings of EUT are considered and two major alternatives to EUT are described.

1.4.1 Economic approaches to decision making

The start of decision making theory could, arguably, be attributed to Blaise Pascal's "Pensées", published in the 17th century (Hacking, 2006). Pascal introduced a rational model to select between different prospects, each with more than one possible outcome and with different probabilities and values, by optimizing the expected value. The expected value of a prospect is calculated by identifying all the probabilities and outcomes and subsequently multiplying them:

$$EV(x) = \sum_i p_i * x_i \qquad [1.1]$$

The 'rational choice' is for the prospect with the highest expected value. It took another century until Daniel Bernoulli demonstrated the limitations of expected value as basis for the normative analysis of decision making under uncertainty. He proposed to calculate expected utility instead.

Expected Utility

In 1738, Daniel Bernoulli published his "*Specimen theoriae novae de mensura sortis*" (Exposition of a new theory on the measurement of risk). In this work, he describes a gamble, which since became known as the St. Petersburg dilemma (Starmer, 2000; Bernstein, 1996). In this gamble, a coin is tossed and continues to be tossed until head turns up. An initial pay-out is established and doubles each throw until head turns up (i.e. the pay-out = 2^n, with n the number of throws until head turns up, and 2 the initial pay-out). The expected value of this gamble is infinitive, however as Bernoulli rightfully pointed out (1954, p.31)[1]: "*no one would purchase it at even a moderately high price*".

Bernoulli suggested that people, instead of optimizing the monetary value of the prospect, optimize the personal utility attached to this value. As such, he offered a solution to the paradox and laid the foundation for a theory that, still today, is a dominant theory in the decision making literature (Hardaker and Lien, 2010; Grüne-Yanoff, 2007; Hastie, 2001; Sarin and Weber, 1993). The optimal choice under expected utility is calculated in a similar fashion as when optimizing expected value, however, (monetary) values are first transformed in utilities (Bernstein, 1996):

$$EU(x) = \sum_i p_i * U(x_i) \qquad [1.2]$$

The utility function, i.e. the transformation of (monetary) value into utility, can be understood as the decision maker's preference for risk. Bernoulli argued that utility always increases when the monetary value increases, but with diminishing returns (Bernoulli, 1954, p. 25): *"…any increase in wealth, no matter how insignificant, will always result in an increase in utility which is inversely proportionate to the quantity of goods already possessed*".

[1] In 1954, "Econometrica" published the original manuscript of Bernoulli translated into English by Dr. Louise Sommer

Such a concave utility function suggests risk averse behaviour, i.e. a certain value is appreciated higher than a prospect with the same expected value: EU(g) > U(EV(g)) (Starmer, 2000). Alternatively, a convex utility function implies risk seeking behaviour (See 1.5.1).

Expected utility became popularized with von Neumann and Morgenstern's (1947) axiomatic treatment of the theory (Just and Peterson, 2010; Starmer, 2000). They demonstrated how expected utility could be derived from four simple axioms: completeness, transitivity, independence and continuity (Karni, 2014):

Completeness means that for any prospect the decision maker can always indicate its preference between the possible states (including no preference). Hence, all states can be compared and the relative preference can be ranked.

Transitivity means that if a prospect A is preferred over B and B is preferred over C, then it follows that A is preferred over C. This axiom requires decision makers to be logically consistent in their choices.

Independence means that the preference for prospects is stable and not biased by the context in which they are presented. This means that the preference for prospect A over B holds whether they are presented directly or embedded in a larger prospect: If U(A) > U(B), then U(p*A + (p-1)*C) > U(p*B + (p-1)*C).

Continuity entails that the preferences for alternatives are expressed on a nominal scale and that no preference for an alternative can be indefinitely larger than that for another alternative (Karni, 2014). This axiom is explained using an example of three prospects in which the preferences are arranged from higher preference to lower preference. From the continuity axiom, it follows that it is always possible to create new prospects, that combine the most preferred prospect and the less preferred prospect, for which the preference is indifferent to the preference for the intermediate prospect. Assuming: U(A) > U(B) > U(C), then there is a possible p for which U(p*A + (p-1)*C) = U(B).

If all four axioms are satisfied in making a decision, the decision maker is maximizing utility (Grüne-Yanoff, 2007).

Subjective Expected Utility SEU

The standard theory of expected utility assumes that the decision maker assigns probabilities to the various outcomes that are equal to the objective probabilities, measured as relative frequencies (Karni, 2014; Simon, 1959). However, uncertainty and risk stem from a lack of knowledge, hence it only exists in the mind of the beholder (Sjöberg, 2000a). As individual perceptions differ from one person to another, it is not the objective probabilities but rather the perceived or subjective probabilities that drive the decision maker.

Already before the seminal work of von Neumann and Morgenstern, Ramsey (1931) and de Finetti (1937) independently formulated conditions under which subjective probabilities and utility could be inferred from observed choices (Karni, 2014). Savage (1954) integrated subjective probability in the standard model of EU. This Subjective Expected Utility (SEU) model allows for distinguishing between the utility function and subjective probabilities when explaining choice. As such, the SEU model offers a solution to the observation that in reality the independence axiom is systematically violated. For instance, small probabilities are often overestimated and different conclusions can be derived from the same information based on how it is presented (Tversky and Kahneman, 1974)(see section 1.4.3). These and other violations of the axioms led to a range of adaptations of EUT.

Generalized expected utility models

Since the formulation of EUT in terms of axioms by von Neumann and Morgenstern (1947), and the extension to include subjective probabilities by Savage (1954), a number of restrictions to the theory were demonstrated. Two particular persuasive reviews on the shortcomings of EUT, known as the Allais (1953) and Ellsberg (1961) paradox, describe how actual choice behaviour may systematically violate one or more of the axioms. As a reaction to these and other demonstrated limitations, many adaptations to the EUT model followed. Some of these are now referred to as generalized expected utility models (Camerer, 1989), as they all have in common that they maintain the general scheme of EUT. Models that fit within this scope of generalized expected utility include, but are not limited to: weighted expected utility (Chew and MacCrimmon, 1979; Fishburn, 1978); anticipated utility, later known as rank-dependent utility (Quiggin, 1982); and relative utility (Dyer and Sarin, 1982). A review of generalized EUT is given by Starmer (2000).

In addition to the models that extent EU, similar critiques about the limitations of (general) EUT were formulated outside the field of economy, notably psychology and political sciences. Hereunder, first the major objections to the rational decision maker, as assumed under EUT and in neo-classical economics in general, are formulated. Thereafter, three major theories on decision making from outside the field of economy are reviewed.

1.4.2 Limitations of rational choice theories

EUT offers an eloquent solution to the problem of decision making under risk. Particularly appealing is its simplicity, in which (subjective) probability and attributed utility are taken into account. However, EUT poses little explanatory power in actual decision making (Starmer, 2000; Wilson et al., 1993). The main limitations can be linked to the violation of the assumptions on two intertwined points: i) human cognition is not compatible with the implicit assumptions made in EUT; ii) decision environments are more complex than assumed in EUT.

The first objection comes, primarily, from the cognitive sciences (Nielsen, 2009). Cognitive research has demonstrated that humans do not reason according to the assumptions of EUT (Nielsen, 2009; Starmer, 2000; Jones, 1999). EUT assumes decision makers to be completely informed about all the possible outcomes of their

choices. To all these possibly outcomes, the decision maker then has to attach a quantitative weight in order to calculate the expected utility for each option. However, humans have limited information processing capabilities (Nielsen, 2009). Especially short term memory, or working memory, has been shown to be a bottle neck for such comprehensive (mental) calculations, as humans are restricted to process no more than seven 'chunks' of information at one time (Miller, 1956). Furthermore, information processing is likely to be serial (Townsend and Fifić, 2004) or sequential rather than simultaneous as is assumed by EUT (Nielsen, 2009). Also, the assumption that high probability low impact risk is equal to low probability high impact risks (the expected utility is exactly the same), is not supported by neuro-imaging studies, which observe different activity patterns (Glimcher et al., 2009). Finally, humans are not accustomed to working with probabilities (Hogarth, 2014; Byron, 2005).

EUT also assumes that decision makers have stable preferences for risk taking. This, however, has been disputed by a large body of evidence that demonstrates that risk preferences or attitudes are far from stable (Hansson and Lagerkvist, 2012; Nicholson et al., 2005; Weber et al., 2002; Kahneman and Tversky, 1979). Kahneman and Tversky (1974) were among the first to show systematic biases in judgements under risk. More recently, increasing evidence points to the idea that judgement is based on the context of the decision problem (e.g. Reynaud and Couture, 2012). In extremis, this suggests that an independent utility function needs to be assessed for each and every situation, as such, the EUT loses much of its parsimony (Nielsen, 2009).

A second major objection is that the environment in which decision making takes place is often more complex than assumed under EUT (Konar et al., 2013; Schlüter, 2009; Wilson et al., 1993). In EUT, the decision environment is conceptualized as a choice over prospects, i.e. known outcomes with known (or estimable) probabilities. However, in reality these probabilities are rarely known nor easy to estimate (Rottenstreich and Kivetz, 2006). People also never know all the available options, thus undermining the necessity for maximization. Moreover, searching for additional options in itself has a (cognitive) transaction cost (Byron, 2005). It has been shown that in reality decision makers make trade-offs between multiple, often incommensurable, goals, rather than optimizing one goal (i.e. the maximum utility) (Simon, 1959). The very fact that goals are incommensurable, by definition means that they cannot be considered on the same scale (Byron, 2005). The actual cognitive decision making process is thus not only incompatible with the assumptions of EUT, but would make optimization impossible all together.

A final problematic assumption regarding the decision process in EUT is the assumed maximization of self-interest. A large body of literature indicates that humans demonstrate altruistic behaviour (Fehr and Rockenbach, 2004; e.g. Fehr and Fischbacher, 2003; Gintis et al., 2003). Altruistic behaviour invalidates the idea of the rational decision maker optimising self-interest. EUT counters this by arguing that utility can be derived from the joy of helping others. This argument, however, does not only potentially increase the problem of incommensurability of

conflicting goals, but also would extend EUT beyond the point where it is no longer workable (Nielsen, 2009). In this line of reasoning, any behaviour could be regarded as resulting from optimising self-interest. Yet, without specifying how utility is calculated, the model loses the ability to be used as normative or predictive tool (Nielsen, 2009).

1.4.3 Non-economic models for decision making under risk

As discussed, the generalized EUT models are a reaction to the limitations of classical EUT, but still retain the fundamental assumptions of rationality. Insight from the field of psychology and political sciences, however, lead to the development of different kind of models, that refrain from assumptions about absolute rationality and logic positivism (van den Bergh et al., 2000). These models attempt to provide a procedural explanation of decision making under risk; that is, they explain the processes that underlie risky choice (Grüne-Yanoff, 2007; Starmer, 2000). These procedural models, have in common that they often explain the difference between actual behaviour and rational choice as caused by heuristics and biases in our rationality (Starmer, 2000). These models are typically describing decisions rich in context and are often less suited as general models for prescribing optimal behaviour (Starmer, 2000). The well-known theories of bounded rationality and prospect theory are described below just as the psychometric paradigm that investigates risk perception and risk attitude.

Bounded rationality

Simon (1955) first introduced the idea of bounded rationality as a reaction to the assumed rationality in expected utility theory. He argued that decision makers are limited in their rationality, for instance they have incomplete utility function, face problems judging probabilities, and lack the cognitive capacity to calculate expected utilities. As maximising utility would therefore be too demanding, Simon proposed the concept of "satisficing" instead (Byron, 2005). Satisficing, which etymologically is derived from the integration of the words optimizing and satisfying, is a fundamental principle of bounded rationality (van den Bergh et al., 2000). The idea behind satisficing is that decision makers do not have access to all information (especially as gathering information itself involves transaction costs) and therefore stop searching for alternatives if one option offers satisfactory outcomes (Simon, 1959). Satisficing is compatible with incommensurability, since different goals do not have to be compared or utility does not need to be calculated. Instead, the only consideration is whether different outcomes are satisfactory or not (Byron, 2005).

Prospect theory

Prospect Theory (PT) was developed by Kahneman and Tversky (1979) as a reaction to the strict assumptions regarding rationality in EUT. The authors observed systematic deviations of the actual behaviour form that was predicted by EUT, for example overweighting of small probabilities. Given the complexity of real-world judgements, people tend to use heuristics or rules of thumb to simplify the decision process, resulting in these systemic deviations, or cognitive biases (Tversky and Kahneman, 1974). PT explains how decisions under uncertainty are made as a two phase process, containing an editing and evaluation phase (Starmer, 2000). As

such, PT proposes a procedural theory to model real life choices, rather than prescribing how choice ought to be made, such as performed in EUT.

This first phase is not comparable to any of the generalized EUT models. In the first phase, various prospects are 'edited'. This editing entails that, instead of acting as if perfect knowledge is acquired, the decision maker uses decision rules, such as heuristics, to assign utility to the different outcomes (Kahneman and Tversky, 1979). Different outcomes are compared as relative to a reference point, dividing outcomes over gains and losses. In the domain of gains, the utility function is concave, suggesting a risk averse behaviour, while in the domain of losses, the utility function is convex, suggesting a risk seeking behaviour. Furthermore, the slope of the concave part of the function is steeper, suggesting an emphasis on losses compared to gains (Kahneman and Tversky, 1979). The second phase is rather similar to (generalized) EUT, and evaluates the utility of different prospects.

Cumulative Prospect Theory is an adaptation of the PT model by the same authors (Tversky and Kahneman, 1992) and allows for weighting the probability distribution in a similar manner as in rank-dependent expected utility (Quiggin, 1982). Rank dependence suggests that not the absolute outcome but rather the rank of the outcome is regarded in the outcome distribution.

Psychometric paradigm

The psychometric paradigm is rooted in psychology and decision theory (Rippl, 2002). An important assumption in the psychometric approach is that risk is seen as a lack of knowledge and does not exist outside human cognition (Slovic, 2010). Therefore, risk cannot be measured independently of our minds and culture (Slovic, 1992). The psychometric paradigm offers a theoretical framework to measure risk perception and risk attitude (McDaniels et al., 1995). Typically, a list of risk events is presented in a survey and rated on different psychometric scales. These scales refer to various characteristics that shape the perception of risk, such as, knowledge of the risk, threat and probability of occurrence. The most important determinants of why individuals or groups differ in their perception of risks are identified by means of multivariate statistics (McDaniels et al., 1995). The psychometric paradigm has been used in much of the recent literature on risk perception and has provided a set of reliable factors that account for the perception of risk (Sjöberg et al., 2004). For example, this approach elucidates the finding that knowledge of the risk and dread are often the most important factors influencing risk perception (Boholm, 1998).

1.5 The role of risk attitude and risk perception in explaining behaviour

Most of the decision theory available, including those described in the section above, focuses on risk attitude in determining risk behaviour. Risk perception is only taken into account implicitly. First, this section provides a description of how

risk attitude and risk perception are taken into account in expected utility and prospect theory. Then, this section will turn to the need to take perceptions more explicitly into account. Finally, a short overview of methods that take perceptions and attitude explicitly into account is given.

1.5.1 Risk attitude

The operationalization of risk attitude in studies on decision making in general, and in the agricultural economic literature in particular, are mostly based on EUT (see section 1.4.1). In these models, the curvature of the utility function provides an indicator for risk attitude: A convex utility function implies risk aversion while a concave utility function implies risk seeking behaviour (Starmer, 2000).

Pratt (1964) and Arrow (1965), independently from each other, proposed a set of measures of risk attitude by dividing the negative of the second derivative over the first derivative of the utility function (Szpiro, 1986). These measures are known as the Arrow-Pratt absolute risk aversion and relative risk aversion. Absolute risk aversion is independent from the initial wealth of the decision, while relative risk aversion considers percentages of wealth by scaling the utility function to the initial wealth of the decision maker. Further specification of absolute and relative risk aversion, specifies whether the aversion of risk is constant, increasing (implying a negatively skewed utility function), or decreasing (implying a positively skewed utility function). As such six combinations of risk aversion measures can be derived: Constant Absolute Risk Aversion (CARA), Increasing Absolute Risk Aversion (IARA), Decreasing Absolute Risk Aversion (DARA), Constant Relative Risk Aversion (CRRA), Increasing Relative Risk Aversion (IARA), and finally Decreasing Relative Risk Aversion (DRRA)

As discussed, the measures based on the standard EUT do not differentiate between a true aversion of risk and other factors. For example, differences in marginal value and aversion to uncertainty of outcomes are confounded in the utility function. Dyer and Sarin (1982) proposed an adaptation to EUT that allows to distinguish between the two.

The EUT derived measures for risk attitude are based on the assumption that risk attitude is a stable personality trait. However, a large body of research has proved that the preference for taking or avoiding risks are biased by for example framing effects, risk taking domains, and the context of the decision problem (Willock et al., 1999b). Prospect theory is one theory that explains framing effects (see section 1.4.3). Despite the advantages of PT, the operationalization of risk attitude based on EUT dominates the literature. Farmers' assessment of risk attitude based on PT is occasionally studied (e.g. Bocquého et al., 2014; Collins et al., 1991), but not widely adopted because of PT's complexity (OECD, 2009).

Risk attitude measures based on PT and EUT are a description of the slope of the utility function. As such, they actually measure a more general behavioural tendency rather than an attitude towards risk alone; indeed many factors are confounded in the utility function. In the psychological literature, risk attitude is

seen as an orientation towards taking or avoiding risk and is considered a latent construct that cannot easily be measured (Pennings and Smidts, 2000). Approximations of risk attitude can be derived from indirect assessment, usually by taking a psychometric approach in which risk attitude is self-assessed on Likert scales (Bard and Barry, 2000).

1.5.2 Risk perception

In classical EUT, the assessment of risk is assumed to be equal to objective risk. PT and SEU take into account that decision makers' perceptions of risk differ from "objective probabilities" (Norris and Kramer, 1990). In PT, heuristics and biases in the editing phase transform the objective probabilities to probabilities closer to the actual perception of the decision maker. SEU tries to assess the degree of belief in uncertain consequences or subjective probabilities that farmers attach to various risks. Criticism that SEU would therefore be subjective, has been eloquently put in perspective by Hardaker and Lien (2010, p. 347): "*By assuming that the frequencies observed in historical data will apply in the future, frequentist are actually making a subjective judgement about probabilities, although usually they neither recognise nor admit this fact*". Subjective probability approaches are promising in the way that assessment of risk can be extended to include risks for which frequency data is unavailable (Just, 2003). Furthermore, subjective probability theories include events that occur very infrequent, or have even never occurred (Norris and Kramer, 1990). However, subjective probability approaches also necessarily assume that farmers are able to categorise and quantify risk. Few studies have investigated if and how farmers actually make probability assessments of risks. As such, it is apt to do so (Hardaker & Lien 2010).

The psychometric paradigm offers a framework for assessing risk attitude and risk perception. A possible drawback of the use of self-assessment scales to elucidate risk perception and risk attitude as is performed in the psychometric paradigm, is that these constructs are not independent form each other. As such, a low risk attitude might be the results of a low perception of risk and vice versa. Hence, models should take the influence of risk perception and risk attitude on each other and on risk behaviour into account. Still, models that explain risk behaviour based on both risk attitude and risk perception are scarce (e.g. Cho and Lee, 2006; Ulleberg and Rundmo, 2003; Keil et al., 2000; Sitkin and Weingart, 1995; Sitkin and Pablo, 1992). Furthermore, these studies lead to inconsistent results about the influence of perceptions and attitude on risk behaviour. Hence, further investigation on the topic is required.

Part I:

A psychometric inquiry

Chapter 2

Risk perception, risk attitude and intended use of risk strategies: Evidence and implications

Based on: Wauters, E., van Winsen, F., de Mey, Y., Lauwers, L., 2014. Risk perception, attitudes towards risk and risk management: evidence and implications. Agric. Econ. Czech (Zemědělská Ekonomika). *In press*

Keywords: Risk perceptions, risk attitudes, risk management, mixed method, FADN

Abstract: Comprehensive risk analysis of a business, such as farming, entails questions on what is at stake, how important is a risk concern and how to deal with it. We performed a sequential mixed method, with in-depth interviews in the first stage (n = 35), followed by a survey on the Flemish FADN data (n = 614) in the second, to investigate farmers' risk perception, attitudes towards risk and perceived usefulness of risk management strategies. We find that, rather than short-term volatility in prices, the longer term co-evolution of expenses versus receipts is of major concern to farmers, next to land availability and policy risks. Farmers are shown to be risk neutral. Finally, our results suggest that farmers consider internal strategies, such as debt management, liquidity management and diversification a better option for their farm management compared to risk management strategies that have been extensively studied, such as contracts, futures and insurances.

2.1 Introduction

This Chapter reports the results of a survey eliciting risk perceptions, attitude towards risk and the perceived usefulness of risk management strategies of Flemish farmers. The questions addressed in this survey are: What aspects do farmers find the most worrisome for the future of their business? How much control do they have over these aspects? What is the general attitude of farmers towards risk? And how useful do farmers perceive particular management strategies to ensure viability in uncertain times?

Farmers' risk management strategies are to a large extent guided by their subjective probabilities of adverse events, i.e. risk perception, and their risk preferences, i.e. risk attitudes (e.g. Hardaker et al., 2004). According to Bard and Barry (2000), the key components in risk analysis with a view to develop strategies and policies are identifying the sources of risk, evaluating risk management strategies and tailoring risk advice to the risk attitudes of individuals. As such, sound and representative knowledge about what kind of risks farmers perceive, what their attitudes towards risk are and how they perceive the value of different risk management strategies can offer valuable insights supporting the design of risk management policies and instruments. Understanding farmers' decisions under risk and uncertainty can aid policymakers to achieve their objectives, such as safe and adequate food, reasonable and stable standard of living for farmers and sustainable production (OECD, 2009). Additionally, region-wide surveys are important, in order to inform policymakers, advisers and researchers on the relevant perceptions and intentions about risk and risk management.

Early studies on the subject of how risk management and risk perception are related include the study of Wilson et al. (1988) who surveyed Arizona dairy farmers. The authors found that concerns about inputs such as feed, labour and capital were equally important as fluctuating milk prices and milk production per cow. In addition, they found that farmers' management responses were very consistent with these perceptions, for instance, the surveyed dairy farmers engaged in forward contracting arrangements for feed. In recent times, risk perceptions and the adoption of risk management strategies have been investigated in the U.S. by, amongst others, Patrick and Wilson (1985), Patrick and Musser (1998; 1997), Coble et al. (1999), Mickelsen and Trede (2001), Musser and Patrick (2002) and Hall et al. (2003). Harwood et al. (1999) summarized the results of a number of nation-wide surveys on risk perception and risk management in the U.S, most of which were unpublished. McCarthy and Thompson (2007) reported the results of an Australian survey on risk perception, risk attitudes and risk behaviour. Martin (1996) and Martin and McLeay (1998) investigated the diversity of New Zealand farmers' risk management strategies.

Similar risk management surveys in the EU are scarcer. Meuwissen et al. (2001) studied the risk perceptions and risk management of Dutch livestock farmers. Price and production risk were found to be the most important risks. Insurance schemes were perceived as a relevant risk management strategy, albeit somewhat less by

mixed farmers compared to specialist dairy and pig farmers. Akcoaz and Ozkan (2005) conducted a risk survey in Turkey aimed at identifying and clustering risk sources and risk management strategies. Policy risks and risks associated with prices and production were considered the most significant risk sources, whereas personal risks were among the least important. With respect to risk management strategies, diversification was identified as the most valid option. In general, previous literature confirmed that farmers perceive market risks, production risk and institutional risks to be the most important sources of risk. Further, farmers are shown to be highly risk averse to risk neutral, although no general consensus on risk attitude is found (Reynaud and Couture, 2012).

2.2 Data and methods

2.2.1 Procedure, data collection and variables

We applied a sequential mixed method in this study. Mixed methods are research methodologies where quantitative and qualitative research is combined (Cameron, 2009). Mixed methods are gaining increasing popularity in agricultural and rural studies, in particular when the subject of interest entails personal, social and psychological variables (Phelan and Mulhall, 2007), and examples are plentiful (Wauters and Mathijs, 2013; Haque et al., 2010; Davis et al., 2004). Our study entailed an initial qualitative phase, consisting of in-depth interviews with 35 farmers about their conceptions of risk, uncertainty, shocks and risk management, followed by a quantitative survey to test our findings.

In the first stage of our sequential mixed method, we performed in-depth interviews with farmers to obtain a better insight into the sources of shocks they perceived and the ways in which they deal with these shocks and with future uncertainties. In particular, the in-depth interviews were designed to get an exhaustive overview of the sources of risk and the shocks that farmers perceive and the way they deal with these shocks and with future uncertainties. During these interviews, we avoided as much as possible the use of the word “risk”, since it has been shown that farmers use the notion of risk in different ways (see Chapter 5). Instead, we asked the farmer about uncertainties that make farm management difficult, about shocks and changes that have caused problems to the business and about their worries and uncertainties for the future. In order to gain a better understanding of the different management strategies they apply or did not apply, we asked them how they dealt with the shocks, uncertainties and worries and how they expect to deal with these issues in the future. The advantage of this qualitative stage preceding the actual survey is, first, the fact that we gain a more broad understanding of farmers’ risk perception and risk behaviour and, second, the fact that it prevents us from asking too many researcher-driven questions in the actual survey.

Indeed, the findings from the in-depth interviews influenced the design of the survey in a number of ways. Foremost, it influenced the shocks related to which we assessed risk perception. After the interviews, we had a list of shocks that were more or less commonly shared by most farmers. For these shocks, it is safe to

assume that farmers' risk perceptions are readily accessible. Shocks that are not commonly shared are shocks that are not readily accessible for all farmers, which in the quantitative assessment, can lead to a forced answer that is not really an indication of how the respondent really perceives this shock. Many of the shocks we included in the quantitative survey are the common shocks that are present in the literature. One noteworthy example of a shock that was included as a direct result of the *a-priori* in-depth interviews was "suffering a longer period with insufficient receipts compared to expenses".

The sample for this qualitative data collection was obtained via purposive sampling, a form of non-random sampling in which those individuals from which the researcher expects to obtain the most information are selected (Teddlie and Yu, 2007; e.g. Guarte and Barrios, 2006). One of the approaches followed was to contact different farmers' organisations and ask them for contact details of potential respondents. Another approach was snowball sampling, in which one respondent was asked to provide contact details of other potential respondents. Last, we contacted several farmers randomly, from several contact databases at our institute. The number of respondents was determined using the concept of theoretical saturation (e.g. Douglas, 2003; Goulding, 2002; Locke, 2001), which occurs when no new data is harvested from expansion of the sample. The results from this stage were used to calibrate the survey in the second stage.

In the second stage, we designed a survey to elicit farmers' risk perception, attitudes towards risk and perceptions on the usefulness of different risk management. Risk perception is conceptualized as consisting of subjective probability, subjective impact and subjective influence. Subjective probability was assessed by asking the farmers to score the likelihood of a series of shocks, on a scale from 1 (low probability) to 5 (high probability). Subjective impact in the case that a shock appeared was assessed on a scale between 1 (low impact) to 5 (high impact). Subjective influence was quantified by asking farmers to score the degree of control they experience about the severity of the risk, also on a 5-point scale from 1 (low influence) to 5 (high influence).

The list of shocks to be included in the survey was mainly based on the in-depth interview stage with some validation from previous literature (McCarthy and Thompson, 2007; e.g. Knowles, 2002; Meuwissen et al., 2001). For the list of shocks that were surveyed, we refer to Table 2.2 to Table 2.4 in the results section. Finally, through an open question, we asked farmers to list the most important concerns about the future viability of their business. These three aspects of risk perception, probability, impact and influence, were assessed in a rather generic fashion. We acknowledge that different farmers may relate these shocks to different goals with which the shock may impair. Yet, our goal is to elicit those sources of risk that are most important from the farmers' point of view, and not to elicit those sources of risk that are most important with respect to one common goal, e.g. profit. It is therefore not a problem that different farmers may relate these shocks to different goals, as we elicit those shocks that are most important for their goals.

Risk attitude was measured in this survey in two ways: through a direct measurement, and a psychometric measurement based on a scale. The direct measurement related to a question asking farmers to indicate to what extent they are willing to take risks; it was adopted from previous literature (e.g. Bard and Barry, 2000). The psychometric measurement of risk attitude consisted of a series of items, for which farmers needed to indicate to what extent they agreed with a series of statements about risk taking in general on a 5-point Likert-type item from 1 (strongly disagree) to 5 (strongly agree). The questions themselves were adopted from previous applications and selected from the literature (McCarthy and Thompson, 2007; Pennings and Garcia, 2001; e.g. Bard and Barry, 2000).

Perceptions on the usefulness of risk management strategies were measured by asking farmers to what extent they consider a number of strategies a valid and likely option to deal with risk and uncertainty on their farm. This was scored on a 5-point scale from 1 (definitely not) to 5 (certainly). The strategies that were surveyed are the strategies most often cited in the preliminary in-depth interviews and in previous literature. For the complete list of investigated risk management strategies, we refer to Table 2.7 in the results section.

The survey was sent out in March 2013 to a sample of farmers in Flanders that together comprise the complete local Farm Accountancy Data Network (FADN) sample, a total of 759 farmers. This allowed us to obtain a representative sample of the Flemish agricultural sector. After 4-5 weeks, we received 624 surveys. Upon initial data cleaning, 10 surveys could not be retained for the analysis, due to unreliable scores and/or more than 25% missing values. Hence, our final sample had 614 respondents, which amounts to a response rate of 81%.

2.2.2 Data analysis

First, the data was screened initially, in order to check for outliers and deviation to normality. Since the items are all Likert-type items, most parametric techniques are very robust, even in the case of serious deviations to normality (Norman, 2010). However, as the goal of this paper is also to provide a representative descriptive picture of risk perception, attitude towards risk and risk behaviour, skewness and kurtosis are important characteristics, since they can reduce the information value of statistics such as the mean. All items were found to satisfy the normality conditions, with acceptable skewness and kurtosis statistics between -1 and +1.
Second, internal reliability of the measurement items of the constructs “risk attitude” and “household risk balancing” was tested. The psychometric measurement scale for risk attitude was, based on theoretical foundations, considered a reflective measurement scale. This means that the items are manifestations of the underlying construct, and a change in the construct is believed to cause a change in all items of the measurement scale (Edwards and Bagozzi, 2000). Given the availability of measurement items from previous studies, we used confirmatory factor analysis, using maximum likelihood and varimax rotation, to assess the reliability of this scale. Items with a loading smaller than 0.5 were excluded from the scale. As a validation check, internal reliability of the final psychometric scale for risk attitude was tested with Cronbach alpha.

Third, means and standard deviations were drawn from all variables of interest. Finally, we performed a one-way ANOVA to check whether the results differ significantly between the different farm typologies and size classes in the sample. When this test suggests significant differences between at least two of these groups, a post hoc test was performed to examine which groups had significant differences in mean scores and what the size of this difference was. Since the choice for the best *post hoc* test depends mainly on the equal variances assumption, an *a-priori* Levene's test was performed. When this test revealed equal variances, a Tukey post hoc test was used, otherwise, we used Dunnett's T3. All data analyses were carried out using the SPSS software (IBM Corp, 2010).

2.3 Results

2.3.1 Summary statistics

Table 2.1 describes the summary statistics of the sample. Most farmers are in the business stages 'established and growing' and 'established and stable'. A small percentage is starting up, and around 10% are winding down for retirement. The average age of farmers is 48.54 years, with the large majority between 41 and 60 years of age. Less than 20% is younger than 40. The bulk of farmers received lower technical or vocational education; a small percentage received only elementary education or university education. Higher agricultural or non-agricultural education accounted for 14% of the sample. About one third of the sample was assigned to each of the size classes small, medium and large, with slightly more farms in the large class compared to the small category. Last, about 66% of farmers attract income from other sources besides agriculture.

2.3.2 Risk perception

Table 2.2 shows the average subjective probability of a shock occurring. Based on the subjective probability of a shock, the greatest worries are limited availability of land and/or high land prices, followed by prices, costs and the ratio of expenses versus receipts. Farmers estimate the probability of personal problems and production losses caused by diseases rather moderate. The subjective probability of a shock does not differ according to the size classes to which farms are assigned, except for the probability of exceptionally low prices, which is estimated significantly lower on small farms. Looking at the differences between typologies of farmers regarding subjective probability of shocks (Table 2.2), we find that most farm types exhibit the same pattern as the overall sample.

Table 2.1: Summary statistics of the farmers taking part in the survey

Characteristic	Statistic*
Business stage	
Starting up	2.0%
Established and growing	28.8%
Established and stable	58.3%
Preparing the take-over	3.6%
Winding down for retirement	7.5%
Income from other sources	
0%	34.0%
10%	21.8%
20%	7.8%
30%	9.0%
40%	5.3%
50%	10.4%
60%	4.8%
70%	3.2%
80%	1.9%
90%	0.9%
100%	0.9%
Age (years)	
Average age	48.5
< 40	17.4%
41 – 50	38.9%
51 – 60	36.7%
> 60	7.0%
Education	
Elementary education	1.7%
Lower technical or vocational education	81.1%
Higher education	14.2%
University education	3.1%
Size class**	
0-15 ESU	27.1%
15-25 ESU	34.2%
>25 ESU	38.7%

N = 614; * Percentages are corrected to account for non-responses; ** Size classes are measured in Economic Standard Units (ESU)

A few significant differences are worth mentioning. Most of these differences reflect typical features of that sector, both biophysically and economically. Fruit growers estimate the probability of adverse weather higher than most other farm types, whereas mixed farmers estimate this probability significantly higher than specialist pig farmers. Fruit growers are more exposed to extreme weather conditions, whereas pig farming is mostly indoor and hence, less exposed to changing weather conditions. The probability of having exceptionally low prices was estimated significantly lower by specialist cattle farmers, compared to most other sectors. The risk of suffering from a longer period with insufficient receipts versus expenditures was significantly more likely for specialist pig farmers compared to most other farm types. Greenhouse growers and horticulture farmers estimate the probability of having difficulties to obtain land significantly smaller than several other farm types. The risk of "losing (part of) their subsidies" was estimated significantly higher by arable farmers, cattle farmers, dairy farmers and mixed farmers. There are no significant differences for the shocks: "production loss due to diseases and pests", "exceptionally high costs", "policy risks and personal risks". Size class has no influence on the subjective probability of shocks.

Farmers estimate the impact of most shocks moderately high to high. Exceptionally low selling prices, excessive cost, and suffering longer periods in which the revenue compared to spending is too low have the greatest impact (Table 2.3). Also with respect to the impact of shocks, most farm types have the same pattern as the aggregated population (Table 2.3). Specialist pig farmers judge the impact of adverse weather events smaller than most other farm types, whereas fruit growers judge this impact significantly higher than most farm types. Specialist pig farmers assess the impact of exceptionally high costs significantly higher than most other farm types. The impact of calamities related to land availability was judged significantly higher in arable farms and significant lower by greenhouse growers. The latter judge the impact of the loss of (part of) the subsidies significantly lower than many other farm types, whereas arable farmers, specialist dairy farmers, specialist cattle breeders and mixed farmers evaluate this impact significantly higher. There is no difference in the subjective impact of shocks between size classes.

Table 2.2: Subjective probability of shocks for all farms, by typology and size class

		Type of shock								
	n	**Weather**	**Pests**	**Prices**	**Costs**	**Margin**	**Policy**	**Land**	**Personal**	**Subsidy**
Total	606*	3.02	2.73	3.48	3.58	3.59	3.55	4.04	2.60	3.43
		0.96	*0.78*	*0.90*	*0.99*	*0.88*	*0.92*	*0.99*	*0.93*	*1.14*
Typology										
Arable farms	43	3.12	2.60	3.56	3.74	3.26	3.56	4.26	2.64	3.88
		0.92	*0.91*	*0.81*	*0.96*	*0.80*	*0.98*	*0.66*	*1.10*	*0.83*
Beef farms	49	2.89	2.79	2.89	3.40	3.74	3.47	4.51	2.64	3.80
		1.01	*0.78*	*0.79*	*0.83*	*0.90*	*0.93*	*0.69*	*0.85*	*1.01*
Dairy farms	85	3.05	2.74	3.50	3.54	3.49	3.44	4.19	2.71	3.64
		0.77	*0.76*	*0.77*	*0.96*	*0.77*	*0.91*	*0.78*	*0.84*	*0.99*
Greenhouse grower	57	2.87	2.85	3.48	3.52	3.48	3.29	3.25	2.41	2.76
		1.09	*0.91*	*1.11*	*1.03*	*0.91*	*1.02*	*1.25*	*0.99*	*1.00*
Horticulture	27	3.14	2.65	3.49	3.36	3.42	3.48	3.45	2.70	2.47
		1.03	*0.81*	*0.93*	*0.94*	*0.91*	*0.83*	*1.22*	*0.94*	*1.04*
Mixed cattle	36	3.03	2.78	3.31	3.56	3.67	3.64	4.06	2.67	3.89
		0.81	*0.76*	*0.71*	*0.97*	*0.89*	*0.80*	*0.83*	*0.86*	*1.01*
Mixed crop-lives	123	3.29	2.64	3.49	3.56	3.61	3.76	4.19	2.55	3.83
		0.79	*0.75*	*0.90*	*1.08*	*0.94*	*0.90*	*0.90*	*0.94*	*0.99*
Pig farms	89	2.65	2.84	3.80	3.83	3.85	3.58	4.19	2.53	3.11
		1.12	*0.66*	*0.87*	*1.00*	*0.82*	*0.94*	*0.86*	*0.93*	*1.21*
Size class**										
0-15 ESU	163	3.11	2.68	3.25	3.43	3.53	3.52	4.01	2.64	3.46
		0.98	*0.83*	*0.96*	*1.02*	*0.82*	*0.87*	*1.02*	*0.91*	*1.07*
15-25 ESU	206	3.15	2.76	3.51	3.68	3.58	3.54	4.03	2.63	3.39
		0.93	*0.80*	*0.87*	*0.97*	*0.92*	*0.95*	*0.95*	*0.97*	*1.19*
>25 ESU	231	2.95	2.66	3.63	3.62	3.59	3.50	3.96	2.58	3.19
		1.03	*0.74*	*0.87*	*0.96*	*0.87*	*0.93*	*1.04*	*0.89*	*1.17*

Average values and standard deviations (in italic) regarding the Likert-type item "How likely are the following events to happen on your farm?" from 1 (very unlikely) – 5 (very likely); * Categorisation of farms in farm type led to the removal of 8 farms that were classified in a typology with only 5 or less farms; ** An additional 8 farms had missing values for the variable size class

The combined picture of subjective probability and subjective impact can be presented in a risk map (Figure 2.1), a widely used representation form for risk perception (Hoag, 2009; Quinn et al., 2003; Smith et al., 2000). Most shocks are in the upper right quadrant, i.e. high probability – high impact, meaning that they pose the biggest threats. This is due to our mixed-method of surveying, which ensures that only those shocks that are relevant are included in the survey. Personal risks and problems due to diseases and pests are considered the least important risks. Prices, costs and the longer term margin between expenses and receipts on the hand and land availability on the other are the biggest worries.

Table 2.3: Subjective impact of shocks for all farms, by typology and size class

		Type of shock								
	n	**Weather**	**Pests**	**Prices**	**Costs**	**Margin**	**Policy**	**Land**	**Personal**	**Subsidy**
Total	606	3.52	3.66	4.15	4.05	4.10	3.86	3.82	3.72	3.69
		1.05	*0.98*	*0.77*	*0.87*	*0.78*	*0.86*	*1.02*	*1.09*	*1.15*
Typology										
Arable farms	43	3.79	3.51	4.02	4.05	4.00	3.86	4.07	3.74	3.95
		0.86	*1.12*	*0.83*	*0.72*	*0.72*	*0.75*	*0.91*	*1.00*	*1.02*
Beef farms	49	3.45	3.87	4.11	4.11	4.22	3.91	4.06	3.89	4.21
		1.00	*0.82*	*0.97*	*0.81*	*0.81*	*0.83*	*0.84*	*1.01*	*0.83*
Dairy farms	85	3.60	3.67	4.08	4.00	4.01	3.76	4.06	3.68	4.00
		0.92	*0.90*	*0.69*	*0.83*	*0.72*	*0.78*	*0.84*	*1.04*	*0.89*
Greenhouse	57									
grower		3.57	3.75	4.27	3.86	4.02	3.68	3.18	3.50	3.04
		1.26	*1.05*	*0.76*	*1.10*	*0.84*	*1.03*	*1.16*	*1.16*	*1.09*
Horticulture	27	3.74	3.51	4.07	3.84	3.96	3.68	3.27	3.63	2.61
		1.08	*0.97*	*0.82*	*1.07*	*0.83*	*0.97*	*1.10*	*1.25*	*1.25*
Mixed cattle	36	3.43	3.75	4.03	4.17	4.19	3.97	4.06	3.64	4.42
		0.78	*0.84*	*0.77*	*0.65*	*0.71*	*0.74*	*0.83*	*1.15*	*0.65*
Mixed crop-lives	123	3.66	3.58	4.11	3.98	4.11	4.04	3.89	3.78	4.06
		0.95	*1.07*	*0.75*	*0.90*	*0.78*	*0.84*	*0.94*	*1.10*	*0.85*
Pig farms	89	3.04	3.74	4.36	4.39	4.22	3.89	3.88	3.80	3.30
		1.21	*0.95*	*0.66*	*0.65*	*0.81*	*0.85*	*1.09*	*1.05*	*1.32*
Size class										
0-15 ESU	163	3.52	3.56	4.07	3.95	4.01	3.84	3.71	3.78	3.72
		1.05	*1.04*	*0.87*	*0.92*	*0.80*	*0.87*	*1.09*	*1.15*	*1.07*
15-25 ESU	206	3.71	3.68	4.19	4.13	4.12	3.84	3.82	3.70	3.68
		0.95	*0.94*	*0.72*	*0.80*	*0.78*	*0.88*	*0.96*	*1.07*	*1.17*
>25 ESU	231	3.44	3.62	4.18	4.06	4.09	3.82	3.75	3.63	3.41
		1.18	*1.03*	*0.79*	*0.91*	*0.79*	*0.89*	*1.09*	*1.09*	*1.28*

Average values and standard deviations (in italic) regarding the Likert-type item "How serious is the impact on your farm of the following events when they occur?" from 1 (very small impact) to 5 (very large impact)

Farmers estimate their influence on all shocks rather low (Table 2.4). The highest influence, albeit still moderate, is believed to be exerted on production losses due to diseases and pests. There is almost no difference in the subjective control exerted on the severity of a shock between farm types. Specialist pig farmers believe to have significantly less control on the severity of adverse weather effects than greenhouse growers and horticulture farmers. There is no difference in perceived influence according to size class.

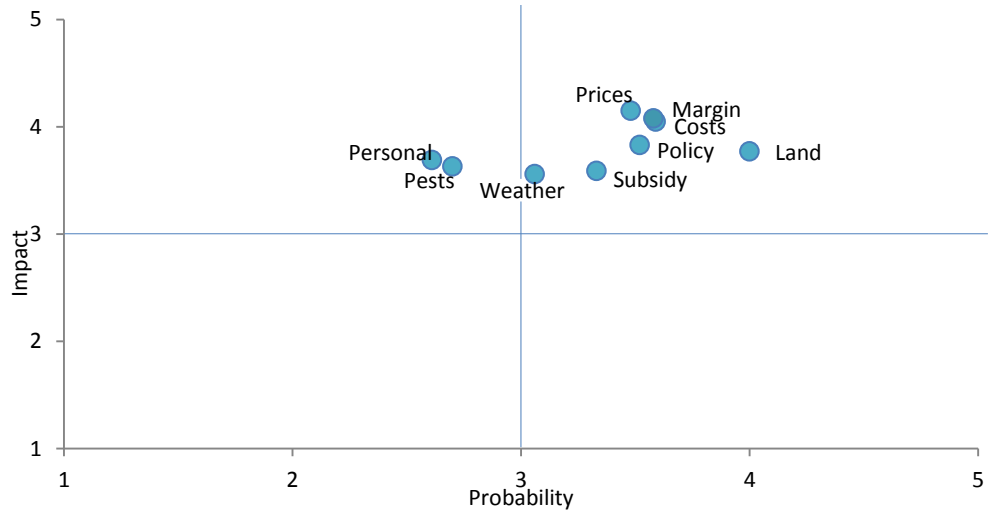

Figure 2.1: Risk map indicating probability and impact of the various surveyed shocks (N=614)

Table 2.4: Perceived influence on the severity of all shocks, by typology and by size class

		Type of shock								
	n	**Weather**	**Pests**	**Prices**	**Costs**	**Margin**	**Policy**	**Land**	**Personal**	**Subsidy**
Total	608	2.21	2.88	2.05	2.16	2.42	2.11	2.17	2.50	2.04
		1.15	*1.10*	*1.17*	*1.20*	*1.16*	*1.13*	*1.19*	*1.18*	*1.19*
Typology										
Arable farms	43	2.40	3.07	2.37	2.44	2.86	2.42	2.42	2.79	2.30
		1.22	*1.10*	*1.22*	*1.26*	*1.13*	*1.10*	*1.28*	*1.21*	*1.32*
Beef farms	49	2.04	2.76	1.98	2.11	2.33	2.15	2.09	2.65	2.04
		1.11	*1.12*	*1.20*	*1.20*	*1.27*	*1.21*	*1.35*	*1.14*	*1.17*
Dairy farms	85	2.24	2.78	2.15	2.24	2.45	2.27	2.42	2.60	2.12
		1.00	*1.05*	*1.13*	*1.11*	*1.03*	*1.16*	*1.29*	*1.17*	*1.21*
Greenhouse	57									
grower		2.55	3.00	2.08	2.24	2.55	2.11	2.06	2.42	2.09
		1.27	*1.07*	*1.36*	*1.29*	*1.26*	*1.08*	*1.14*	*1.18*	*1.08*
Horticulture	27	2.88	3.40	2.18	2.27	2.47	2.25	2.34	2.65	1.98
		1.24	*0.94*	*1.09*	*1.15*	*1.12*	*1.07*	*0.96*	*1.09*	*1.06*
Mixed cattle	36	2.08	2.58	2.08	2.19	2.31	1.94	2.14	2.56	2.03
		1.08	*1.11*	*1.16*	*1.19*	*1.21*	*1.17*	*1.13*	*1.32*	*1.25*
Mixed crop-lives	123	2.07	2.66	1.89	2.04	2.30	1.88	2.00	2.30	1.97
		1.09	*1.05*	*1.01*	*1.05*	*1.03*	*1.05*	*1.08*	*1.21*	*1.22*
Pig farms	89	1.82	2.94	1.94	2.03	2.34	2.07	2.08	2.41	1.94
		1.00	*1.21*	*1.32*	*1.40*	*1.30*	*1.22*	*1.29*	*1.16*	*1.20*
Size class										
0-15 ESU	163	2.35	2.79	2.12	2.22	2.45	2.16	2.31	2.57	2.12
		1.18	*1.13*	*1.20*	*1.15*	*1.13*	*1.16*	*1.23*	*1.17*	*1.20*
15-25 ESU	206	2.20	2.87	1.97	2.10	2.42	2.03	2.08	2.49	2.06
		1.13	*1.08*	*1.12*	*1.15*	*1.13*	*1.12*	*1.17*	*1.17*	*1.15*
>25 ESU	231	2.17	3.00	2.05	2.18	2.46	2.14	2.23	2.46	1.98
		1.16	*1.12*	*1.18*	*1.26*	*1.21*	*1.13*	*1.21*	*1.17*	*1.19*

Average values and standard deviations (in italic) regarding the Likert-type item "How much control do you have over the severity of the following events?" from 1 (no control) – 5 (very much control).

Farmers also had the opportunity to indicate by means of an open question, which aspects they believe constitute the greatest threat to their business. In contrast to

the average response to open-ended questions in surveys, the response to this open-ended question was quite large: 368 of the 614 farmers (60%) have completed this question. The processing and reporting of these results were done in 2 steps. First, all answers were listed, and all answers were given a specific code, referring to a risk issue. Second, a number of codes were aggregated into major themes. These are reported in Table 2.5, which also shows how often elements classified in these themes were mentioned.

The advantage of this open question is that, together with the in-depth interviews in the first stage, it enables us to document the argumentation behind the risk perception results, i.e. why certain shocks and issues are a concern to farmers. The first interesting finding is the huge link between price, costs and the margin between expenses and receipts on the one hand, and policy changes on the other. Farmers perceive many policy measures to have an immediate impact on costs and prices. As such, the concern about the longer term ratio between expenses and receipts is not driven mainly by an increase in the costs of production as such, but by the fact that policy measures induce additional costs to be incurred. Examples are policy measures related to manure, land conservation, animal welfare and food safety.

A second noteworthy finding is that price and costs risk are conceptualized as worries about the longer term margin between prices and costs, rather than as short-term, in-season volatility of prices. This is shown by the abundance of quotes that could be assigned to either costs, prices or the ratio between expenses and receipts and the low number of quotes that specifically refer to price volatility. This focus in agricultural economic literature on short-run risk versus the potentially more important long-term risk issues has been acknowledged by Just (2003) as an opportunity or challenge for risk research in agricultural economics. In fact, of the two risks – price risk and production risk – that are most often investigated in the risk research literature, production volatility, although not the biggest concern, is identified as a concern to farmers, but price volatility is not. This has important consequences for the practical use of much price risk research, in which price risk is almost invariably conceptualized as volatility in prices of both input and output. Farmers regard such volatilities more as certain variability. Much more challenging than managing volatilities in prices is safeguarding the longer term margin between expenses and receipts. This worry is induced by the uncertainty about the future evolution of prices versus costs, and also by farmers' past experience. With regard to the latter, many farmers describe a situation that is known in the literature as Cochrane's treadmill (Cochrane, 1958), referring to the necessity to invest in new technology and thereby increasing structural costs, only to see future prices drop to a level producing a less favourable margin between expenses and receipt than before.

The third and last prominent theme was land availability and land prices. This is a particularly relevant situation in a densely populated area such as Flanders, whereas many different users put a claim on land, thereby lowering availability and raising prices.

Table 2.5: Coded responses to the open question "What are the biggest risks concerning your farm?"

Codes and sub-codes	Times mentioned
Margin between expenses and receipts	193
Too low prices	75
Too high costs	64
Higher expenses than receipts	54
Policy	133
Too much regulation	37
Too many administration and inspection	21
Policy changes too fast	7
Government has no positive vision for agriculture	6
Permits and expandability	10
Loss of grants and subsidies	34
Unfair competition because of the policies in place	15
Abolition of stabilization policies	3
Land	66
Land prices / availability	66
Production losses	56
By weather	32
By diseases in crops	10
By diseases of cattle	14
Health	41
Health / illness in the family	41
Environmental limitations	35
Environmental constraints	20
Manure policy	15
Financial risk	33
High investments to still get low returns	33
Labour	27
Finding suitable and affordable staff	17
Having to work many hours for a small income	10
Acquisitions	25
Willingness and financial feasibility to take over business	25
Autonomy	18
Control over prices	5
Too little competition in distribution channels	2
No market power compared to large buyers and suppliers	8
Method of price setting	3
Scale	17
Too large scale to carry the shocks in the family	3
Not follow scale enlargement plans of colleagues	8
Orientation of policy and industry towards larger scale and specialization	6
Price Volatility	8
Price fluctuations	8

N = 368

2.3.3 Risk attitude

Risk attitude, or the willingness to take risks, is seen as an important determinant of risk behaviour, both in positive and normative analyses. Risk attitude in this survey was measured in two ways. The first measurement method was direct elicitation using a single question. On a scale of 1 (very risk averse) to 5 (very risk taking), the average score is 2.65 suggesting that the Flemish farmer are on average

risk-averse, but not very much. The second measurement method is a psychometric scale consisting of 9 items. Confirmatory factor analysis confirmed that these 9 items were loading on a single construct and all items were retained since all loading exceeded the 0.50 threshold. The internal consistency of this scale (Cronbach alpha = 0.73) is considered good, allowing us to calculate the average of the nine items. The average of this scale is a measure for the latent variable risk attitude and equals 2.76, which leads to the same conclusion as the direct measurement (Table 2.6). The two ways to measure risk attitude were significantly correlated ($p<0.001$) with a correlation coefficient of 0.48. The correlation is very significant, and it is higher than the correlations between different measuring methods we find in the literature (e.g. Maart-Noelck and Musshoff, 2013; Nielsen et al., 2013; Pennings and Garcia, 2001; Pennings and Smidts, 2000).

Table 2.6: Results of the Risk attitude measures

	Direct measure	Psychometric scale
All farms	2.65 (1.01)	2.76 (0.58)
Size class small	2.40 (0.94)*	2.60 (0.55)*
Size class medium	2.60 (0.70)*	2.74 (0.58)*
Size class large	2.88 (1.04)*	2.88 (0.58)*

N = 614; Averages and standard deviations (between brackets) on a scale from 1 (very risk averse) to 5 (very risk seeking)
* p-value < 0.01

The results suggest that farmers are only slightly risk averse, even more on the risk neutral side. This result is contradictory to several previous studies in a European context. Hansson and Lagerkvist (2012), for instance, found that Swedish farmers are risk averse in several domains. In the U.S., Bard and Barry (2000), found that farmer were just in the risk averse zone of their scale.

The degree of risk aversion is uniform across all production typologies and is thus not separately reported here. This result is according to our expectation, since risk attitude is a personal characteristic, and thus there is no reason why risk attitude would differ according to production typology. There is, however, a significant difference in the risk attitude according to the size class of the farms. Larger farms are less risk averse than medium and small farms and medium farms are less risk averse than small farms (Table 2.6).

2.3.4 Perception on the usefulness of risk management strategies

Table 2.7 presents the average usefulness of different risk management strategies. Importantly, several of the most mentioned and investigated risk management strategies, are not considered a valid option by the farmers. Farmers have a slightly negative intention to implement risk management strategies such as contracts, and with respect to the use of insurances and futures (Figure 2.2). The most popular measures are actually internal strategies that farmers already apply since long and that are usually much less often considered in the frame of risk management: maintaining a financial buffer, save on private expenditures, improve technology, avoiding debt and increasing their efforts in difficult times.

Table 2.7: The scores of the perceived usefulness of various risk management strategies

		Size class			
Strategy	**All**	**Small**	**Medium**	**Large**	**Status***
Maintain financial buffer	4.02 (0.84)	3.95 (0.91)	4.09 (0.83)	4.02 (0.80)	-
Cut private spending	3.76 (1.04)	3.69 (1.10)	3.69 (1.05)	3.84 (0.99)	-
Technological optimization	3.55 (0.90)	3.35 (1.04)	3.47 (0.85)	3.77 (0.80)	s < m, l
Debt management	3.32 (1.11)	3.61 (1.09)	3.24 (1.14)	3.16 (1.07)	s > m, l
Work hard in difficult times	3.18 (1.03)	3.02 (1.01)	3.19 (1.03)	3.28 (1.01)	-
On-farm diversification	3.10 (0.97)	3.20 (0.99)	2.99 (0.99)	3.14 (0.93)	-
Scale enlargement	3.00 (1.11)	2.72 (1.11)	3.05 (1.10)	3.14 (1.09)	s < m, l
Contracts	2.76 (1.13)	2.56 (1.12)	2.76 (1.09)	2.91 (1.15)	-
Off-farm income	2.65 (1.38)	3.04 (1.44)	2.63 (1.36)	2.37 (1.29)	s > m, l
Income diversification	2.64 (1.25)	2.93 (1.35)	2.55 (1.21)	2.50 (1.18)	s > m, l
Extra-legal insurances	2.59 (0.96)	2.59 (1.00)	2.51 (0.94)	2.66 (0.94)	-
Futures	2.24 (0.96)	2.25 (0.99)	2.29 (0.95)	2.20 (0.96)	-
Non-agricultural investments	2.19 (1.10)	2.38 (1.24)	2.13 (1.05)	2.12 (1.01)	s > m, l

N = 614; Average values and standard deviations (between brackets) regarding the question "To what extent would you, regarding your farm, consider the following strategies to protect yourself against financial uncertainty?" from 1 (definitely not) – 5 (definitely); *status refers to the significant difference between small (s), medium (m) and large (l) farms, only significant ($p<0.05$) relations are reported

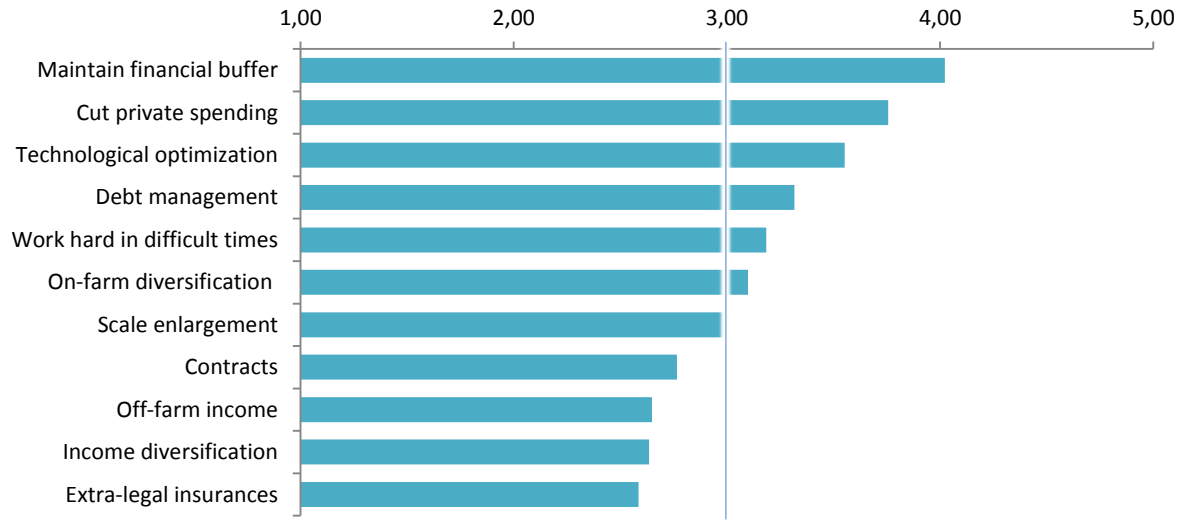

Figure 2.2: Perception on the usefulness of various risk management strategies (N=614)

We also investigated whether there exist any trade-offs between the willingness to apply different risk management strategies. Several scholars point to the crowding out effect of one risk management strategies vis-à-vis other risk management strategies (e.g. OECD, 2009). We measured correlation factors between the implementation intentions of all risk management strategies. We found modest correlations, although often significant. However, most correlations are positive, suggesting that a higher willingness to implement a particular risk management strategy is associated with a higher willingness to implement other strategies as well. Hence, farmers find a mixture of different risk management strategies very beneficial to manage risk and uncertainty. One noteworthy exception is the most

popular strategy, maintaining a financial buffer. Farmers who find this strategy a valid option for their farm are significantly more inclined to dislike strategies such as insurances, futures and investments outside agriculture. This could suggest that for many farmers, maintaining a financial buffer is the only feasible and valid option to manage farm risk.

The perceived usefulness of risk management strategies differs very little depending on the production typology, and is therefore not separately reported here. There are only two significant differences. First, off-farm income is considered a less valid option by greenhouse growers compared to dairy farmers, beef farmers and mixed farmers. Second, extra-legal insurances are considered significantly more an option for orchard and fruit farmers compared to arable farmers, cattle farmers and pig farmers.

There are some differences according to the size class of the farms. Small farms find technological optimization and modernization and scale enlargement a significantly less valid option compared to medium and large farms. These small farms, however, regard off-farm strategies such as non-agricultural employment, non-agricultural investment, and diversifying income sources as more beneficial for managing risks compared to medium and large farms.

2.4 Discussion and conclusions

Farmers perceive several sources of risk and uncertainty that are a worry to them and most of the sources identified in our study relate to the common risk sources mentioned in previous literature. However, a major result of our survey is that, rather than in-season and short-term volatility in prices, the longer term ratio of expenses versus receipts is a bigger worry to farmers. This is not reflected in the abundance of research related to price risk, which uses price volatility, often measured on historical data, as a proxy for price risk. It is an empirical confirmation, however, of the statement made by Just (2003, p.153) in his position paper on the future of risk research in agriculture: "*Data availability constraints can and do bias research away from investigating some of the most important problems.*". In the U.S., Mickelsen and Trede (2001) obtained a similar result, showing that narrowing margins is what farmers are most concerned about in terms of price and market risks. The much higher importance that is attached by farmers to longer term evolution of prices and costs and, in particular, to the longer term ratio between expenses and receipts, highlights the importance of collecting panel data and investing more time and effort in panel data research in a risk framework. The fact that farmers, when prices and costs are a concern, are much more concerned about the co-evolution and shrinking margins also questions equating "risk" with "volatility", a common approach in risk analysis and management research (Aven, 2010a).

We find that production losses to diseases and pests are considered a relatively smaller risk compared to several previous studies. This contrasts the findings of, for

instance, Meuwissen et al. (2001), who find that epidemic diseases are among the top worries for farmers. Whereas their sample is limited to livestock farmers, in our survey, we find no evidence that livestock farmers attach higher importance to livestock diseases than the average farmer over all subsectors. This result can explain to a certain extent the low uptake of animal health management technologies. The relatively lower importance of production risks could be explained by several context-specific aspects. First, although adverse weather events such as summer droughts or late frost do occur, the climate in Belgium may be considered moderate compared to some of the regions in which previous studies were conducted. Second, farmers in Belgium did not recently suffer a major epidemic crisis, the last crisis being the EHEC-crisis in 2011. We think the results of a survey on risk perception may be biased by recent events, and recent events in Belgium are more dealing with market risks as compared to production risk. Third, during our qualitative pre-survey, we also observed a cultural difference between perceptions of market risk and production risk. Whereas suffering low output prices and/or high input prices is regarded as a complete matter of good or bad luck, the occurrence of production losses is partly considered as a matter of good or bad management. We think this view of production risks as partly manageable explains to some extent the relatively lower importance that was attached to production risks.

Our risk attitude results differ from some previous studies in the sense that several previous studies identified farmers as more risk averse than we did. Yet, our study is not the first and only to identify farmers as being more in the risk neutral spectrum. Some of the differences with those studies that defined farmers as risk averse may have a cultural background, in that farmers in the Flemish region of Belgium are generally regarded as a bit more entrepreneurial than in many other countries. However, this is just a word of mouth statement and clear comparative evidence does not exist. Given the inherent riskiness of the farm business, we consider our results very plausible.

The farmers in our sample prefer internal strategies for managing risk rather than strategies such as contracts, insurances and futures. This could be partly explained by the observation that, rather than short-term price volatility, the longer term ratio of expenses versus receipts is one of the major concerns for farmers. Risk management instruments such as futures and contracts protect farmers from in-season deviations from the expected prices. They do not protect the farmers, however, from longer term price evolutions. Policymakers should take this into account when designing policy measures aimed to assist farmers in managing on-farm risks.

A cultural reason why strategies such as insurances and futures are not regarded as relevant strategies by the farmers in our sample, may be the fact that these strategies are currently rather unfamiliar to farmers in Belgium. Whereas extra-legal insurances for farmers, for instance, are quite common in many countries, their availability in Belgium is low for the moment. Hence, the opinions about such strategies might change if these strategies become more available and are applied

more often. A methodological reason could be that an anchoring effect has occurred in our survey. We did not ask respondents to compare the risk management strategies vis-à-vis each other. Yet, the first strategy that the respondents had to score was "maintaining a financial buffer", which is regarded as the most relevant strategy. An anchoring effect may have influenced the scores, i.e. the respondents use the first strategy as the norm and score all subsequent strategies with respect to this first one.

In many countries, the focus of agricultural policy is nowadays directed towards insurances. Whereas we do not question the relevance and usefulness of insurances, our results suggest the need for stimulating more diversification in risk management strategies. The reluctance of farmers to subscribe to extra-legal insurance, unless high premium subsidies are paid by the government, has previously been described by, amongst other, Freshwater (2007). He argues that farmers already take risk into account in their internal management, using strategies such as debt and liquidity management and diversification. Given the high relevance, from the point of view of farmers, of risk management strategies such as debt and liquidity management, it could be recommendable that some of the efforts and means of policy programs are directed towards providing conditions that support debt and liquidity management and measures to reduce credit risk. This could include the provision of cheap loans to overcome short-term cash flow deficits, or investment support instruments.

The use of a sequential mixed method, where qualitative research precedes the quantitative data collection, enables focussing the survey on the relevant issues, which bears substantial methodological advantages. First, it avoids posing suggestive questions resulting in misleading results. This phenomenon can occur when questionnaires are developed from a researcher's perspective and the closed question format induces farmers to provide an answer to a question even though the question is not relevant from the farmers' point of view. When conducting surveys aimed at eliciting farmers' key perceptions and opinions, this may produce misleading results about the relevance of particular issues. Second, it allows reducing the questionnaire to a minimum length, which benefits greatly the response rate and the reliability of the survey answers. Third, a qualitative data collection stage enables eliciting the broader reasoning and argumentation behind certain perceptions and opinions, which is hampered when solely using closed survey questions. For these reasons, we advocate the use of a sequential mixed method in survey research aimed at assessing farmers' key perceptions and opinion on a particular matter. In particular the last reason enabled us to find a deeper understanding of risk perceptions of farmers. Most previous studies found price and production risk the most relevant risk sources, which, at first sight, is well reflected in the risk analysis and management literature. Yet, since agriculture is the process of transforming inputs into output (production) and selling these outputs at prices that – hopefully – are high enough to earn a profit over and above the costs incurred for using the inputs, it is hardly surprising that price and production risk is a concern. However, our mixed method enabled us to get a deeper understanding about what it actually is about prices that is a concern to

farmers, namely the narrowing margin between expenses and receipts, rather than short-term, in-season volatilities in prices.

Chapter 3

Linking perceived sources of risk and risk attitude to explain the intended use of risk strategies

Based on: van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., Wauters, E., 2014. Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. Journal of Risk Research. *In press*

Keywords: Risk perception, risk attitude, risk management, structural equation model (SEM)

Abstract: The importance of risk perception and risk attitude for understanding an individual's risk behaviour is independently well described in literature, but rarely combined in an integrated approach. In this study, we propose a model assuming the choice for risk management strategies to be directly driven by both perceptions of risks and risk attitude. Other determinants influence the intention to apply risk strategies mainly indirectly, mediated by risk perception and risk attitude. This conceptual model is empirically tested, using structural equation modelling. Data are gathered in a survey completed by 500 farmers from the Flanders region in Belgium, investigating attitudes towards farming, perceived past exposure to risk, socio- demographic characteristics, farm size, perceptions of the major sources of farm business risk, risk attitudes and the intention to apply common risk management strategies. Our major findings are: (i) perception of major farm business risks have no significant impact on the intention of applying any of the risk strategies under study, (ii) risk attitude does have a significant impact. Therefore, rather than objective risk faced and the subjective interpretation thereof, it is the general risk attitude that influence intended risk strategies to be implemented. A distinction can be made between farmers willing to take risk, who are more inclined to apply ex-ante risk management strategies and risk-averse farmers who are less inclined to implement ex-ante risk management strategies but rather cope with the consequences and diminish their effects ex-post when risks have occurred.

3.1 Introduction

From a realist perspective, it is assumed that "real risk" can objectively be measured (Zinn, 2008). Individual perceptions of risk, however, differ from one person to another (Slovic et al., 1982). The choice of individuals to act upon risk, i.e. their risk behaviour, depends on the individuals' assessment of the risk involved. Hence, risk perception is an important determinant of risk behaviour and many studies have investigated this relation (e.g. Boholm, 1998; Renn, 1998b; Slovic et al., 1982).

Another key factor in determining how farmers respond to risk is believed to be risk attitude (Dave et al., 2007; Pennings and Garcia, 2001; Willock et al., 1999a; Weber and Milliman, 1997). Risk attitude or sometimes referred to as risk preference, risk aversion or risk propensity, is the actor's orientation towards risk taking. Risk attitude can vary from very unwilling to take risk (risk averse) to very willing to take risk (risk seeking). Different persons hold different attitudes towards risk which causes them to deal differently regardless of their individual perception.

Although, risk perception and risk attitude are independently well described in literature, much less research has been performed relating to the interaction between risk perception and risk attitude and on how they collectively guide risk behaviour (Keil et al., 2000; Sitkin and Pablo, 1992). However, in order to understand risk behaviour, it is imperative to simultaneously consider risk perception and risk attitude. For one, risk attitude affects risk behaviour directly (Menapace et al., 2012; e.g. Holt and Laury, 2002; Pennings and Smidts, 2000) but it has been shown that it also affects risk perception and therefore risk behaviour indirectly (Nielsen et al., 2013; Menapace et al., 2012; Cho and Lee, 2006; Keil et al., 2000; Sitkin and Weingart, 1995; Sitkin and Pablo, 1992). In this Chapter, we investigate the influence of risk attitudes, risk perception and several background variables on farm-level risk management.

Farming offers a very interesting case study to investigate risk behaviour, since it is increasingly confronted with risk and uncertainty arising from various sources such as production risk, price volatility, personal risks and policy changes (Hardaker et al., 2004). Furthermore, decisions are made largely by a single person aiming not only at maximizing production and profit but also at sustaining the farming vocation (Willock et al., 1999a). Therefore, the individual's choice of risk management strategies is of vital importance for the viability and continuation of the farm business.

Given the importance of good risk management, farm managers, agricultural-advisers and extension agents seek to understand the decision-making process of farmers with respect to potential risk management strategies. Producers may not always understand that their choices are different from other producers due to personal differences in their perception and attitudes, rather than being driven by external influences and structural barriers. Further, agricultural policymakers are increasingly determined to liberalize agricultural market and price formation,

thereby substituting market regulation policies (such as price interventions, export subsidies and production quota) by sectorial risk management instruments (such as direct payments and insurance schemes). In order to anticipate farmers' responses to such changes in agricultural policy, policymakers also need a better understanding of farmers' intentions to apply different risk management strategies. The first objective of this study is to increase understanding of the intention of farmers to apply different risk management strategies.

We further aim to contribute to the research field studying the influence of risk perception and risk attitude on risk behaviour. In essence, our model investigates the determinants of intended risk behaviour and how these determinants interact, or mediate each other. Although this is an empirical investigation, we argue that the findings can be generalized to a wider context. Therefore, the second objective of this study is to contribute to the research on the relative contribution of perceived risk and risk attitude and of the direct and mediated effects of other known determinants on the intended adoption of risk management strategies.

In the next paragraphs, we present our theoretical model, explain the main concepts and their relations and develop the hypotheses. Next, the data and methodology are illustrated and the main results are described. In the last sections, we discuss our results and conclude.

3.2 Conceptual model and hypotheses

The conceptual model presented in this study exposes how perceptions of risk and risk attitude can influence the intended decision to implement risk management strategies at the farm level (intended risk behaviour). Other determinants of the intended risk behaviour, like perceived past exposure to business risk and farming attitude, determine risk behaviour only indirectly, i.e. mediated by risk perception and risk attitude (indirect determinants). Our conceptual model is presented in Figure 3.1.

3.2.1 Risk management strategies

Farmers cope with risk and uncertainty in different manners. Commonly known strategies include: avoiding financial problems (avoiding large credit dependency or keeping buffers for times of financial hardship), obtaining an off-farm income, using external risk management strategies (forward contracts or crop insurances), diversifying production or income sources and saving on private expenditure (Hardaker et al., 2004).

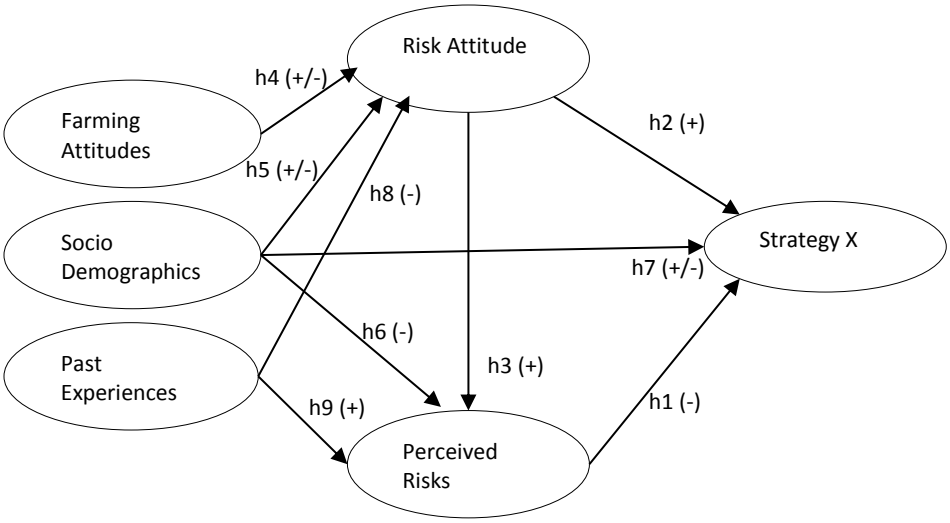

Figure 3.1: The risk behaviour model showing the hypothesised relations between the investigated determinants of risk behaviour: + positive expected influence, - negative expected influence, +/- the sign of the relation is subject of the study

We recognize that farmers can and do apply a variety of these, and other, risk management strategies. As such, in this study, we investigate the effect of perceived risks and risk attitude on multiple risk management strategy. Further, rather than measuring actual risk behaviour, we measure intended risk behaviour, i.e. to what extent farmers consider different risk strategies a valid option for their farm.

3.2.2 Perceived risks and risk attitude

Perceptions of risk differ between individuals, caused by differences in the objective risks the individuals are facing and/or because the subjective interpretation of the risk differs (Sjöberg, 2000a). It is expected that for individuals with a higher perceived risk, the intention to actively engage in management to control the risk is bigger. Hence, we propose the following hypothesis:

H1: Perceived risks will significantly and positively influence the intention to implement risk reducing strategies.

Risk attitude has been described in economic and psychological literature. In economic literature, risk attitude is described in the expected utility framework (EUT) (Pennings and Garcia, 2001). At the heart of EUT lies the assumption of diminishing returns of utility. Risk attitude can be measured as the curvature of the utility function, i.e. to what extent an increase in value is considered an equal increase in utility. As such, risk attitude is typically regarded as stable over time, different domains and context (Dohmen et al., 2011). However, in prospect theory it is proposed that decision makers are risk averse in the domain of gains and risk seeking in the domain of losses (Kahneman and Tversky, 1979). Furthermore, risk attitude is thoroughly described in psychological literature. Within this tradition, risk attitudes are often assumed to differ over domains and even time, i.e. decision makers can be simultaneously risk seeking and risk averse in different domains (Hansson and Lagerkvist, 2012; Starks and Trinidad, 2007; Pennings and Smidts, 2000). Conversely, it has been shown recently that differences in risk behaviour

across domains can often be ascribed to a different perception of the risk while risk attitudes remain stable (Weber et al., 2002; Weber and Milliman, 1997). We conceptualise risk attitude as a personal orientation towards taking or avoiding risk that is persistent and stable, but evolves over time as influenced by experience (Cho and Lee, 2006; Sitkin and Weingart, 1995). We expect that the more willing the farmers are to take risk, i.e. the higher their risk attitude, the less inclined they are to implement any risk reducing strategy. Hence, we propose the following hypothesis:

H2: Risk attitude will have a significant and negative relation with the intention to implement risk reducing strategies.

Furthermore, we investigate the influence of risk attitude on risk perception. Previous studies have demonstrated that the relation between risk attitude and risk perception is negative, i.e. a person that is more (less) willing to take risk will have a lower (higher) (subjective) perception of risk (Nielsen et al., 2013; Cho and Lee, 2006; Keil et al., 2000; Sitkin and Weingart, 1995; Sitkin and Pablo, 1992). Hence, we propose the following hypothesis:

H3: Risk attitude will have a negative effect on perceived risk.

3.2.3 Indirect determinants

Besides perceived risks and risk attitude, we test the influence of farming attitudes, socio-demographics, farm characteristics and perceived past exposure to risk on intended risk behaviour. These determinants are in the first place acting as control variables. However, each of them is expected to have an influence on intended risk behaviour, albeit mainly mediated by risk attitude and perceived risk. This is in line with previous studies putting perception and attitude in a central role in explaining intended risk behaviour (Cho and Lee, 2006; Keil et al., 2000; Sitkin and Weingart, 1995; Sitkin and Pablo, 1992). An exception holds for the socio-demographic and farm structural variables which are expected to also impose a direct influence on intended risk behaviour.

Farming attitudes are reflecting thoughts, opinions and ideas of farmers about their profession as a farmer and the farming sector in general. Examples of farming attitudes include the satisfaction of the farmers with their profession, future expectations about the sector as a whole, stands towards sustainability at their farms, perceived importance of training and/or being up to date with the newest farming technologies and other similar attitudes related to their farming occupations. Farming attitudes are hypothesised to be a predictor of the risk attitude.

The socio-demographic and farm variables under study are: age of the farmer, the level of education of the farmer and the size of the farm. We chose to exclude information about the subsector of the farm as a control variable as we found that this is not a factor of significant difference.

Farm and farmer characteristics are known to influence risk perception (Ahsan, 2011). Age, for instance, is known to have a positive effect on risk perception, i.e. older individuals perceive the same risk as bigger compared to younger ones (Cohn et al., 1995; Otani et al., 1992). Farm size is also demonstrated to be positively correlated with perceived risk (Lucas and Pabuayon, 2011). The level of education on the other hand is generally believed to be negatively correlated with risk perception, i.e. lower level of education are associated with higher risk perception (Savage, 1993).

Farm and farmer characteristics also influence risk attitude. Age is a well-known predictor for risk attitude and it was established that age has a negative relation with risk taking or on risk attitude (Vroom and Pahl, 1971). The potential effect of education on risk attitude is less evident, as it has been assumed to be both negative, i.e. higher educated decision makers are more risk averse (Harrison et al., 2007b; Bar-Shira et al., 1997) and positive, i.e. more willingness to take risk with increasing level of education (Hartog et al., 2002; Moscardi and Janvry, 1977). Farm size and firm size in the wider sense have usually been appointed to affect risk attitude positively, either directly (Feder, 1980) or mediated via income (Fiegenbaum and Thomas, 1988).

We believe that age and farm size also have a direct (not mediated) effect on risk behaviour. We hypothesise that for certain decisions or certain choices of risk management strategies, socio-demographics and farm characteristics can act as a constraint. For instance, we could imagine that very large farms cannot increase their scale any further and older farmers are less likely to invest in modernization.

The last indirect variable under study is perceived past exposure to risk. We expect that perceived past experience with risk will have a negative and significant effect on risk attitude, i.e. when a farmer experienced more risk in the past he will be more averse to risk in the present. Furthermore, we expect perceived past experience to be positively and significantly related to perceived risk, i.e. a farmer stating to have experienced high risk in the past will perceive more risk in the present.

In summary, we hypothesise that the control variables will influence the intended use of the risk management strategies. In some cases, they will influence them directly, while in other they will influence them indirectly, being mediated by the perceived risks or risk attitude. All expected relations in our model and their signs are further clarified in Table 3.1.

3.3 Data and methods

3.3.1 Data collection

To test our hypotheses, empirical data were gathered using a survey mailed in April 2013 to a sample of 759 farmers in Northern Belgium (Flanders), which constitutes the entire sample of the local Farm Accountancy Data Network (FADN). The FADN

data set consists of micro-level data based on harmonized bookkeeping principles across all EU member states. It is stratified to ensure representativeness regarding the agricultural regions and farm sizes within Belgium. The survey was preceded by 35 in-depth interviews exploring the famers' conception of risk and risk management. The survey consisted of several parts measuring the different constructs in the theoretical model and was based on both the preliminary interviews and literature research. Before sending out the survey, it was pretested and discussed with experts in the field, after which some questions were dropped, added or rephrased (the final survey can be found in Appendix 1).

Table 3.1: The hypothesized relations and their signs based on the literature review: + positive expected influence, - negative expected influence, +/- the sign of the relation is controversial

Relation	Sign
H1a: Perceived Price Risk > Intended Risk Behaviour	+
H1b: Perceived Production Risk > Intended Risk Behaviour	+
H1c: Perceived Institutional Risk > Intended Risk Behaviour	+
H2: Risk Attitude > Intended Risk Behaviour	-
H3a: Risk Attitude > Perceived Price Risk	-
H3b: Risk Attitude > Perceived Production Risk	-
H3c: Risk Attitude > Perceived Institutional Risk	-
H4a: Job satisfaction > Risk Attitude	+/-
H4b: Prospection > Risk Attitude	+/-
H4c: Progressiveness > Risk Attitude	+/-
H5a: Age > Risk Attitude	-
H5b: Level of Education > Risk Attitude	+/-
H5c: Farm Size > Risk Attitude	+
H6a: Age > Perceived Price Risk	+
H6b:Age > Perceived Production Risk	+
H6c: Age > Perceived Institutional Risk	+
H6d:Level of Education > Perceived Price Risk	-
H6e: Level of Education > Perceived Production Risk	-
H6f: Level of Education > Perceived Institutional Risk	-
H6g: Farm Size > Perceived Price Risk	+
H6h: Farm Size > Perceived Production Risk	+
H6i: Farm Size > Perceived Institutional Risk	+
H7a: Age > Intended Risk Behaviour	+/-
H7b: Level of Education > Intended Risk Behaviour	+/-
H7c: Farm Size > Intended Risk Behaviour	+/-
H8: Past Experience > Risk Attitude	-
H9a: Past Experience > Perceived Price Risk	+
H9b: Past Experience > Perceived Institutional Risk	+
H9c: Past Experience > Perceived Production Risk	+

In May 2013, we had recovered 624 surveys, of which 124 surveys with missing data were removed. Hence, our final sample size counted 500 respondents,

amounting to an effective response rate of 66%. The comparison of our final sample with the excluded respondents and non-responsive farmers revealed no biases towards variables such as age, education, farm type, specialisation or size. Hence, the results are deemed representative for the whole farming population. An overview of some key characteristics of the sample population is given in Table 3.2.

Table 3.2: Summary statistics of the farmers and their farms in the sample

	Description	Frequency	Percent
Age (years) *	< 41	84	16,8
	41 - 50	202	40,4
	51 - 60	187	37,4
	> 60	27	5,4
Business phase**	Starting	10	2,0
	Settled and growing	130	26,0
	Settled and stable	276	55,2
	Preparing for takeover	15	3,0
	Preparing for pension	33	6,6
Education	Primary school	7	1,4
	High school	402	80,4
	Under graduate	75	15,0
	Graduate	16	3,2
Sector	Specialist field crops	35	7,0
	Specialist horticulture	89	17,8
	Specialist permanent crops	47	9,4
	Specialist grazing livestock	140	28,0
	Specialist granivore	85	17,0
	Mixed cropping	11	2,2
	Mixed livestock	38	7,6
	Mixed crops-livestock	55	11,0
Economic Size Class (ESU)	0-15 ESU	130	26,0
	15-25 ESU	177	35,4
	>25 ESU	193	38,6

n = 500 ; * mean age is 48, minimum age is 25 and maximum age is 69; ** for Business phase: n = 464, due to missing values in 36 surveys.

Risk management strategies

Relevant risk management strategies were identified in the qualitative data collection stage, compared with literature and reviewed by experts. We measured famers' intention to adopt different risk management strategies (in the near future) on a scale from 1 (would definitely not apply) to 5 (would definitely apply). The list of items used in this study as input for the strategies under study can be found in Table 3.3 in the results section.

Perceived risks and risk attitude

Risk can be regarded as the combination of the probability of an uncertain event happening and the incidental impact or negative consequence (Mellers and Chang,

1994; Dunegan et al., 1992). Indeed, a risk will increase when the probability increases, the magnitude of the impact increases or both increase. Therefore, we asked the farmers to score perceived probability of different risk sources on a five-point scale from 1 (very unlikely) to 5 (very likely) and perceived impact for each source on a five-point scale from 1 (very small impact) to 5 (very big impact). Perceived risk scores were calculated by multiplying the associated scores of perceived probability and impact of the different risk sources. This is a common way to elucidate risk perceptions in questionnaires (e.g. Hoag, 2009; Quinn et al., 2003; Smith et al., 2000). The list of the risk sources that were included in the survey was based on the in-depth interviews and literature study (McCarthy and Thompson, 2007; Knowles, 2002; Meuwissen et al., 2001) and can be found in Table 3.4.

Risk attitude was measured with different statements on financial risk taking behaviour. The respondents needed to score their agreement with these statements on a five-point Likert-type item from 1 (strongly disagree) to 5 (strongly agree). The statements were based on previous studies investigating risk attitude (McCarthy and Thompson, 2007; Pennings and Garcia, 2001; Bard and Barry, 2000) and can be found in Table 3.4.

Indirect determinants

The indirect determinants in our model consist of two socio-demographic variables (age and level of education), a farm structural variable (farm size), attitudes towards the farming profession and the perceived past exposure to risk. Socio-demographic and farm structural variables are derived from the farm accountancy network data. Farming attitudes and perceived past exposure are latent variables.

General attitudes towards the farming profession were measured with statements for which the respondents had to indicate their agreement on a scale from 1 (totally disagree) to 5 (totally agree). The statements were adopted from previous studies such as the study of McCarthy and Thompson (2007) on risk behaviour of Australian farmers. Previous exposure to risk was measured using self-assessment items rating the volatility of farm incomes and household income over the past five years on a scale from 1 (totally disagree) to 5 (totally agree). The items used can be found in table 3.5.

3.3.2 Analysis

All survey items were first checked for outliers, skewness and kurtosis. All of the items were deemed sufficiently normally distributed and hence suitable for further parametric analysis. Next, we performed exploratory and confirmatory factor analysis on the items of the survey, hence reducing the amount of variables to fewer but more meaningful latent variables. Those latent variables represent the majority of the factors in our model: farming attitudes, perceived past volatility, risk attitude, perceived risks, and intended use of risk strategies and are discussed in the measurement model section of the results Chapter. We use these latent variables in our structural models to test the relationships between them, hence testing our

hypotheses. Below, the factor analyses and structural equation modelling are described in more detail.

Measurement models

For both the exploratory and confirmatory factor analysis, we distinguished dependent and independent factors, as we expected correlation between them. The factor extraction method used was maximum likelihood which is generally assumed better than Principle Component Analysis (PCA) for the purpose of investigating the relations between different latent factors (Ford et al., 1986). In the exploratory factor analysis, no significant correlations between the factor loadings were found, therefore orthogonal rotation (Varimax) was used. In none of the analyses, Kaiser-Meyer-Olkin test (KMO-test) was lower than 0.5, suggesting that we could proceed with the factor analysis (Hair et al., 2006). Bartlett's test of sphericity was always found to be significant ($p < 0.05$), so correlations in the dataset were present, i.e. no identify matrices were found (Hair et al., 2006). The criteria used to include items from the questionnaire in a factor were: communalities > 0.5, rotated factor loadings > 0.4, no two rotated factor loadings > 0.5 (Hair et al., 2006; Ford et al., 1986).

Structural models

Our conceptual risk behaviour model was analysed using structural equation modelling. While risk strategies are correlated, and since it is not our aim to test the magnitude and sign of these correlations, we opted to construct an individual model for each of the risk strategies. We tested two sets of models; in the first set the indirect determinants are excluded and in the second set they are included. We opted to exclude the indirect determinants in these first models in order to elucidate the unconditioned effect of perceived major sources of risk and risk attitude on the decision to adopt risk management strategies.

The second set of models includes the indirect determinants in order to validate the findings of the first model and analyse the effects of these indirect determinants on intended risk behaviour. By including the indirect determinants, the latent variables representing perceived risk become endogenous and cannot be correlated witch each other. However, a correlation exists and can be partly attributed to factors not included in the SEMs, e.g. a general tendency to perceive risk as large or small, or anchoring (an initial score will be the “anchor” for following scoring by the respondent in the survey). Although it is not our aim to test the correlations between the different perceived risks, we allow for such omitted variables to cause correlation in the different perceived risk sources by correlating their error terms, which is justified in this situation (Kline, 2011).

Several model fit indices were considered to establish a satisfactory model fit: CMIN/DF (the ratio between χ^2 and the degrees of freedom) < 3.000, Root Mean square Residual (RMR) < 0.05, Goodness of Fit Index (GFI) > 0.95, Comparative Fit Index (CFI) > 0.95, Root Mean Square Error of Approximation (RMSEA) < 0.08 preferably < 0.06 (Hair et al., 2006; Schreiber et al., 2006). All coefficient scores are

standardized in order to facilitate comparison. Both the measurement models and the SEMs are estimated using IBM SPSS AMOS.

3.4 Results

Both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were used to distract the latent variables from the items scored by the farmers in the survey. The subsequent measurement models of the extracted latent variables (risk strategies, risk perception and attitude and indirect determinants) are presented below. Next, the different SEMs, that test the hypothesized relations between these latent factors, are presented.

3.4.1 Measurement models

Risk management strategies

Exploratory and confirmatory factor analysis for risk strategies validated six different strategy types: diversify, external, optimize, coping, off-farm and buffer (Table 3.3). “Diversify” is a factor that captures the tendency to use diversification as a risk reducing strategy and is constructed of two items measuring the tendency to diversify sources of income and production. “External” refers to the use of external risk management strategies and is constructed with three items measuring the tendency to use price contracts, futures and insurances for risk management purposes. “Optimize” refers to the strategy of managing risk by optimizing the production process and is constructed of two items measuring the tendency to modernize and to enlarge the scale of the farm as a risk management strategy. “Coping” is a strategy based on the inclination to allow risk and cope with the consequences; the two items that construct this factor are measuring the tendency to save on private spending and work harder in times of financial hardship of risk. “Off-farm” is the first factor constructed with a single item and refers to the tendency to obtain an off-farm income or have another person in the household earning an income away from the farm. “Buffer” is the last factor and the second measured with a single item, it reflects the tendency to avoid financial risk by always keeping a buffer for times in need. The fit indices of the measurement model for the risk management strategies show a good model fit and the loading factors are all above 0.4 (Table 3.3), which is deemed adequate in social sciences when sample size exceeds 350 (Hair et al., 2006; Ford et al., 1986). The result of the KMO-test was 0.59, and Bartlett's test of sphericity was significant ($p<0.001$).

Perceived risks and risk attitude

Factor analyses for establishing the latent variables representing the perceived major sources of farm risk were performed using the perceived risk scores. Three categories for risk perception are recognized each of which are measured with two items. These three categories are reflecting three of the major farm business risk sources: price risk, production risk and institutional risk (Table 3.4). In fact, these risk sources are recognised as the biggest concerns of farmers (Harwood et al., 1999).

Table 3.3: Measurement model for risk strategies: 5 different risk strategies were revealed: diversifying income, use of external risk managements strategies, technological optimization, coping with risk, obtaining an off – farm income and keeping a financial buffer

Standardized regression weights and model fit						
	Risk Strategies:					
Survey Items:	**Diversify**	**External**	**Optimize**	**Coping**	**Off-farm**	**Buffer**
Diversifying income (tourism, farmers market)	1.01					
Diversifying production	.41					
Obtaining price contracts		.47				
Hedging on future markets		.57				
Buying non-obligatory insurances		.44				
Investing in technical optimization of farm			.70			
Investing in scale enlargement			.67			
Working harder in times of financial uncertainty				.82		
Postponing private purchases				.45		
Obtaining an off-farm income					1	
Keeping a financial buffer						1

n= 500; fit indices: $\chi 2 = 78.753$, Df = 31, CMIN/Df = 2.540, $p < 0.001$, RMR = 0.048, GFI = 0.973, CFI = 0.911, RMSEA = 0.056

Price risk represents the perceived risk of having too low market prices or too high input prices to cover the costs of production. Production risk combines the perceived risk of production loss due to extreme weather conditions and disease. Institutional risk is a latent factor representing the perceived risk of losing some subsidies (often vital for farm survival) and other changes in regulations that can have negative impact on the farm business. All latent factors related to perceived risks were measured with two variables. The fit indices indicate good model fit and the factor loadings are all higher than 0.40 (Table 3.4). The result of the KMO-test was 0.78, and Bartlett's test of sphericity was significant ($p<0.001$).

Risk attitude was measured using four items. These items are measuring the level of fondness in risk taking, inclination towards postponing risk, level of carefulness with financial risk and tendency towards taking up financial risk for an expected risk premium. The factor loadings are all above 0.40 and the model fit indices for risk perception and risk attitude indicate a good model fit (Table 3.4). The result of the KMO-test was 0.77, and Bartlett's test of sphericity was significant ($p<0.001$).

Indirect determinants

The factor analyses on the items measuring farming attitudes and perceived past exposure enabled us to convert nine items in four latent factors (Table 3.5). The derived factors are “job satisfaction”, “progressiveness”, “prospection” and “perceived past exposure to risk”. Job satisfaction is representing the farmers’ fulfilment with their profession and farming lifestyle and is measured with two items. Progressiveness is measured with three items that represent the proactive attitude of farmers to be up to date with the latest information and technology needed to manage their farms. Prospection is the last farming attitude we take into account and is explaining the vision that farmers have on the persistence of farming

in Flanders. Finally, perceived past exposure is a variable that expresses the stated experience with risk, it is constructed with two items measuring the volatility of the farm and household income. The regression weights and model fit indicators of the measurement model are given in Table 3.5. The model fit is high and the factor loadings are all above 0.40. The result of the KMO-test was 0.60, and Bartlett's test of sphericity was significant ($p<0.001$).

Table 3.4: Measurement models for direct determinants of risk behaviour

	Standardized regression weights and model fit			
	Risk attitude	**Risk Perception**		
		Price	**Production**	**Institutional**
I do not like to take risky decisions concerning my farm (reversely coded)	.53			
I postpone investments until they really need to be done (reversely coded)	.68			
I am usually very careful when it comes to financial decisions regarding my farm, like loans and investments. (reversely coded)	.78			
I am not afraid to borrow money in order to do investments that can enhance profitability	.49			
Perceived risk: Exceptionally high cost prices		.58		
Perceived risk: Too little revenues considering the costs over a long time period		.80		
Perceived risk: Loss of production due to (extreme) weather conditions			.40	
Perceived risk: production loss due to diseases and pests			.68	
Perceived risk: Unexpected changes in regulation with negative impact on the farm				.91
Perceived risk: Losing of (an important share of) the received subsidies				.46

n = 500; fit indices:
risk attitude: $\chi2 = 1.143$, Df = 2, CMIN/Df = 0.571, p = 0.565, RMR = 0.011, GFI = 0.999 CFI = 1.000, RMSEA < 0.001
risk perception: $\chi2 = 2.556$, Df = 6, CMIN/Df = 0.426, p = 0.862, RMR = 0.012, GF I= 0.998, CFI = 1,000, RMSEA < 0.001

Table 3.5: Measurement model of the indirect determinants of risk behaviour

	Standardized regression weights and model fit			
	Farming attitudes:			**Perceived past exposure**
	Progressiveness	**Prospection**	**Job satisfaction**	
It is important to me to be up to date about the newest technologies concerning my profession	.72			
I enjoy to experiment and I am willing to test new ideas	.56			
I regularly go to meetings to speak to, and learn from, other farmers	.51			
There is no future for agriculture in Flanders		.53		
I worry about my future as farmer, but I do not know what else I could do		.93		
If you are a farmer it is because you enjoy it, not for the profits you could make			.42	
I prefer to work with my hands, rather than doing an office job			.48	
The family's budget was very volatile in the last 5 years				.70
The income I received from my farm was very volatile in the last 5 years				.84

n = 500; fit indices: $\chi2 = 30.717$, Df = 21, CMIN/Df = 1.463, p = 0.079, RMR = 0.031, GFI = 0.987 CFI = 0.984, RMSEA = 0.030

3.4.2 Structural models

The first set of models that we investigate excluded the indirect determinants (Figure 3.2). The fit indices of these models indicate an adequate model fit (Table 3.6). The effects of the perceived major risks on any of the strategies are insignificant in all the SEMs (Table 3.7). The effect of risk attitude on the other hand is significant for all. However, the sign of the coefficient is not negative in all cases as was hypothesized. Whereas risk attitude has a negative effect on coping, obtaining an off-farm income and keeping a buffer, it has a positive effect on the decision to mitigate risk using the strategies "diversify", "external risk management" and "optimize".

The second set of SEMs we analysed included the indirect determinants (Figure 3.3). This allowed us to test whether the previous results are confirmed and to determine the effects of the indirect determinants on risk attitude, risk perception and risk behaviour.

The model fit indices of these SEMs show a good model fit for each of the models (Table 3.8). The standardized regression weights and their corresponding p-value can be found in Table 3.9. In this second round of models, it is confirmed that none of the perceived sources of uncertainty have a significant effect on any of the risk management strategies, so hypothesis 1 has to be rejected. Risk attitude does have a significant effect on all strategies except the use of external risk management and in both models (including and excluding the indirect determinants), however the relation is not always negative as was hypothesised so hypothesis 2 is only partially accepted. The influence of risk attitude on perceived price risk is significant, however the influence of risk attitude on perceived production risk and perceived institutional risk is not significant; hence hypothesis 3 can also only be partially accepted.

All of the farming attitudes are significantly and negatively affecting risk attitude. Out of the different farming attitudes, "prospection" shows the biggest effect on risk attitude. The smallest effect on risk attitude comes from "job satisfaction". However, the range of coefficient values, between the three different measured farming attitudes and for all four models of different risk strategies, is very small, suggesting a similar impact of all three farming attitudes on risk attitude.

The effect of age on perceived risk is only significant for production risk. This effect is negative and significant for all risk strategies. Level of education and farm size are not significantly influencing the perceived risks. The effect of age on risk attitude is negative and significant in all six models. The effect of farm size on risk attitude is also significant and the sign is positive. However, the effect of level of education on risk attitude is not found to be significant in any of the four models.

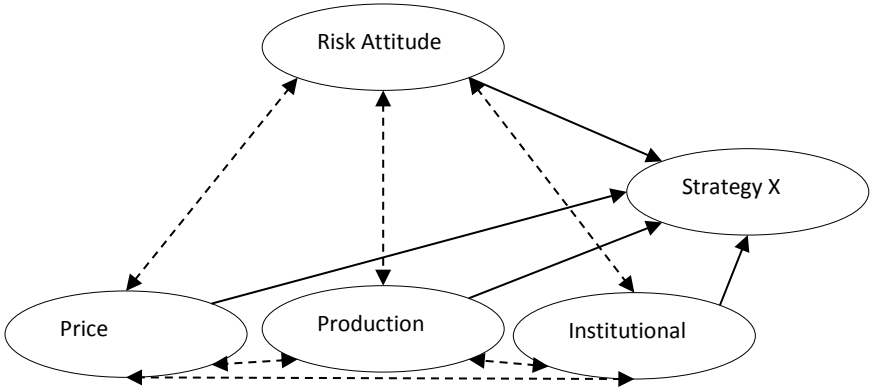

Figure 3.2: Structural model with perceived price, production and institutional risk and risk attitude as sole determinants of the intention to adopt the different risk strategies. Broken lines indicate correlations, unbroken lines indicate causal relation in the direction of the arrow

Table 3.6: Fit indices of the SEMs with risk perception and risk attitude as sole determinants of the intention to adopt the different risk strategies

SEM model	χ^2	Df	p	CMIN/DF	RMR	GFI	CFI	RMSEA
Diversify	60.074	55	0.297	1.092	0.034	0.982	0.996	0.014
External	61.324	55	0.260	1.115	0.035	0.982	0.993	0.015
Optimize	84.363	44	0.000	1.917	0.038	0.973	0.963	0.043
Coping	47.896	44	0.318	1.089	0.032	0.984	0.996	0.013
Off-farm	41.774	35	0.200	1.194	0.032	0.985	0.992	0.020
Buffer	58.291	35	0.008	1.665	0.036	0.979	0.974	0.037

n = 500

*Table 3.7: Coefficients of the SEMs with risk perception and risk attitude as sole determinants of the intention to adopt the different risk strategies, bold = significant at the 0,05 level, *** = p-value < 0.001*

Strategy:	Diversify		External		Optimize		Coping		Off-farm		Buffer	
	coef.	p-value	coef.	p-value	coef.	p-value	coef.	p-value	coef.	p-value	coef.	p-value
H1: Perceived Price Risk > Strategy X	-0.002	0.990	0.006	0.967	0.070	0.598	0.017	0.256	-0.103	0.363	-0.028	0.796
H1: Perceived Production Risk > Strategy X	0.102	0.323	0.054	0.666	0.133	0.238	0.003	0.840	0.021	0.810	0.019	0.830
H1: Perceived Institutional Risk > Strategy X	-0.094	0.287	0.156	0.179	-0.067	0.473	0.011	0.354	0.127	0.135	0.108	0.159
H2: Risk Attitude > Strategy X	**0.099**	***	**0.215**	**0.018**	**0.558**	***	**-0.026**	**0.004**	**-0.257**	***	**-0.206**	***

n = 500

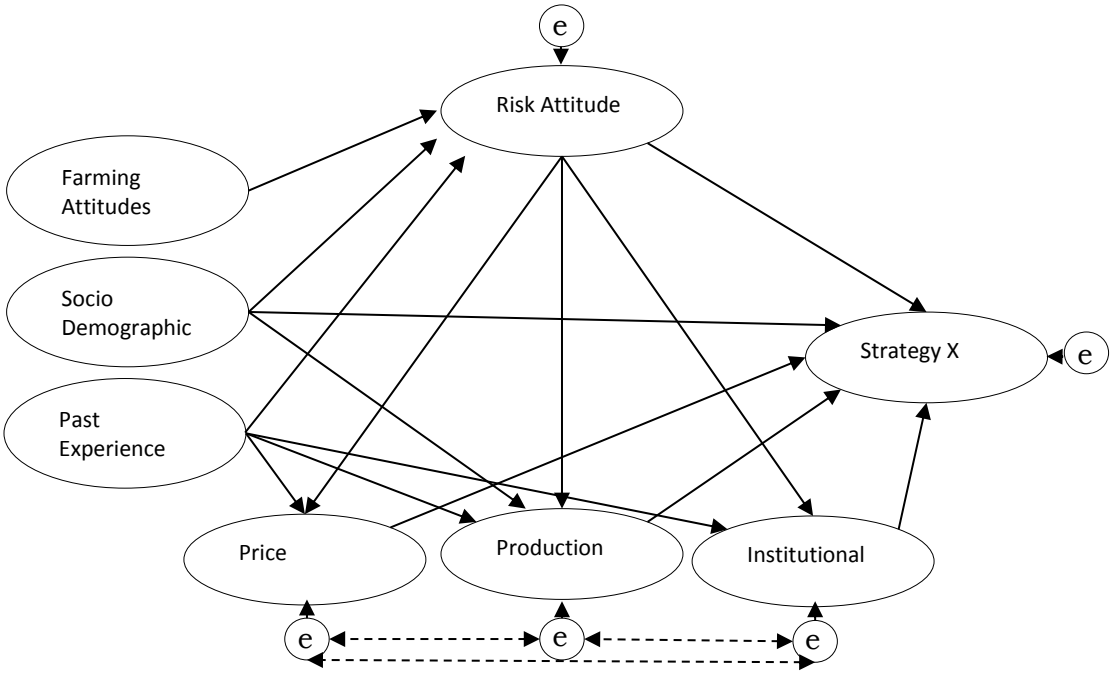

Figure 3.3: Structural model including the indirect determinants of the intention to adopt the different risk strategies. Broken lines indicate correlations, unbroken lines indicate causal relation in the direction of the arrow; e = error term

Table 3.8: Fit indices of the SEMs including the indirect determinants of the intention to adopt the different risk strategies

Strategy:	χ^2	Df	p	CMIN/DF	RMR	GFI	CFI	RMSEA
Diversify	367.475	225	< 0.001	1.633	0.047	0.945	0.935	0.036
External	349.443	225	< 0.001	1.553	0.043	0.948	0.936	0.033
Optimize	391.428	202	< 0.001	1.938	0.046	0.938	0.912	0.043
Coping	331.394	202	< 0.001	1.641	0.045	0.948	0.934	0.036
Off-farm	268.812	181	< 0.001	1.485	0.040	0.956	0.953	0.031
Buffer	297.599	181	< 0.001	1.644	0.420	0.951	0.937	0.036

The direct effect of age on the "optimize" strategy is the only significant effect of age and is negative. Hence, older farmers are less inclined to invest in scale enlargement and modernization of their farms, compared to younger farmers. A second, and only other, significant direct effect of the farm and socio-demographic characteristics on the risk management strategies is the negative effect of farm size on the "diversify" strategy. Farmers with a larger farm are less likely to diversify.

Perceived past experience does not have a significant effect on risk attitude. Past experience does have a significant effect on all perceived risks and over all the four models.

Table 3.9: Coefficients of the SEMs including the indirect determinants of the intention to adopt the different risk strategies

	Diversify		**External**		**Optimize**		**Coping**		**Off-farm**		**Buffer**	
	coef.	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**	**coef.**	**p-value**
H1a: Perceived Price Risk > Strategy X	0.085	0.527	-0.039	0.824	0.138	0.349	0.092	0.274	-0.062	0.614	-0.047	0.699
H1b: Perceived Production Risk > Strategy X	0.087	0.398	0.052	0.693	0.097	0.386	0.007	0.915	-0.021	0.818	0.020	0.828
H1c: Perceived Institutional Risk > Strategy X	-0.140	0.152	0.191	0.145	-0.071	0.497	0.036	0.553	0.127	0.167	0.127	0.141
H2: Risk Attitude > Strategy X	**0.196**	**0.011**	0.194	0.056	**0.596**	***	**-0.157**	**0.001**	**-0.229**	***	**-0.200**	**0.004**
H3a: Risk Attitude > Perceived Price Risk	**-0.359**	***	**-0.359**	***	**-0.371**	***	**-0.352**	***	**-0.359**	***	**-0.359**	***
H3b: Risk Attitude > Perceived Production Risk	-0.132	0.105	-0.130	0.107	-0.133	0.101	-0.128	0.113	-0.130	0.106	-0.130	0.107
H3c: Risk Attitude > Perceived Institutional Risk	-0.123	0.059	-0.123	0.059	**-0.129**	**0.049**	-0.119	0.068	-0.124	0.059	-0.122	0.058
H4a: Job satisfaction > Risk Attitude	**-0.240**	**0.029**	**-0.245**	**0.027**	**-0.226**	**0.034**	**-0.246**	**0.027**	**-0.246**	**0.027**	**-0.240**	**0.030**
H4b: Prospection > Risk Attitude	**-0.311**	***	**-0.314**	***	**-0.336**	***	**-0.326**	***	**-0.316**	***	**-0.304**	***
H4c: Progressiveness > Risk Attitude	**0.285**	***	**0.270**	***	**0.323**	***	**0.261**	***	**0.266**	***	**0.262**	***
H5a: Age > Risk Attitude	**-0.123**	**0.016**	**-0.125**	**0.014**	**-0.116**	**0.021**	**-0.128**	**0.012**	**-0.126**	**0.013**	**-0.124**	**0.015**
H5b: Level of Education > Risk Attitude	-0.063	0.215	-0.063	0.216	-0.064	0.205	-0.065	0.202	-0.063	0.217	-0.060	0.238
H5c: Farm Size > Risk Attitude	**0.175**	***	**0.174**	***	**0.175**	***	**0.174**	***	**0.174**	***	**0.176**	***
H6a: Age > Perceived Price Risk	-0.091	0.090	-0.091	0.090	-0.094	0.082	-0.090	0.092	-0.091	0.091	-0.090	0.094
H6b:Age > Perceived Production Risk	**-0.133**	**0.046**	**-0.132**	**0.046**	**-0.133**	**0.046**	**-0.132**	**0.046**	**-0.132**	**0.046**	**-0.132**	**0.046**
H6c: Age > Perceived Institutional Risk	-0.002	0.975	-0.002	0.974	-0.003	0.954	-0.001	0.979	-0.001	0.992	-0.003	0.959
H6d:Level of Education > Perceived Price Risk	0.038	0.464	0.038	0.468	0.041	0.430	0.039	0.455	0.038	0.472	0.038	0.471
H6e: Level of Education > Perceived Production Risk	-0.003	0.969	-0.005	0.944	-0.001	0.988	-0.004	0.955	-0.004	0.946	-0.004	0.949
H6f: Level of Education > Perceived Institutional Risk	-0.025	0.619	-0.025	0.617	-0.024	0.632	-0.025	0.620	-0.026	0.616	-0.025	0.620
H6g: Farm Size > Perceived Price Risk	0.095	0.085	0.095	0.085	0.099	0.074	0.092	0.097	0.095	0.086	0.094	0.087
H6h: Farm Size > Perceived Production Risk	-0.054	0.429	-0.050	0.455	-0.054	0.431	-0.052	0.442	-0.051	0.452	-0.052	0.444
H6i: Farm Size > Perceived Institutional Risk	-0.023	0.659	-0.023	0.663	-0.021	0.692	-0.025	0.643	-0.026	0.633	-0.021	0.692
H7a: Age > Strategy X	0.011	0.831	-0.093	0.182	-0.161	**0.005**	**-0.065**	**0.046**	**-0.096**	**0.041**	-0.039	0.420
H7b: Level of Education > Strategy X	0.029	0.550	-0.002	0.979	-0.044	0.406	-0.023	0.459	0.014	0.747	0.060	0.188
H7c: Farm Size > Strategy X	**-0.188**	**0.001**	0.026	0.714	0.061	0.308	0.051	0.140	**-0.165**	***	0.087	0.085
H8: Past Experience > Risk Attitude	-0.122	0.064	-0.118	0.074	-0.102	0.114	-0.126	0.056	-0.119	0.070	-0.118	0.073
H9a: Past Experience > Perceived Price Risk	**0.348**	***	**0.347**	***	**0.361**	***	**0.365**	***	**0.345**	***	**0.347**	***
H9b: Past Experience > Perceived Institutional Risk	**0.204**	**0.009**	**0.198**	**0.010**	**0.215**	**0.006**	**0.202**	**0.010**	**0.198**	**0.011**	**0.201**	**0.010**
H9c: Past Experience > Perceived Production Risk	**0.241**	***	**0.240**	***	**0.241**	***	**0.243**	***	**0.246**	***	**0.236**	***

n = 500; bold = significant at the 0.05 level, *** = p-value < 0.001

3.5 Discussion

3.5.1 Implications of the findings

Perceived Risks

Whether price, production, or institutional risk is involved, risk perception does not have a significant impact on any of the intended risk behaviours. Nonetheless, the signs are mainly positive as expected. Hence, those farmers who perceive more risk, either because they objectively face more risk or they have a higher subjective perception of the risks, are not significantly more likely to implement risk reducing strategies. On the contrary, risk attitude does have a significant impact on the intended behaviours.

The finding that the effect of risk perception on risk behaviour is of less importance than the effect of risk attitude, is similar to the proposition of Sitkin and Pablo (1992) that risk propensity is of major importance to risk behaviour. Yet it contradicts the findings of Sitkin and Weingart (1995) and Keil et al. (2000), who found risk perception to be the greatest determinant of risk behaviour. However, the operationalisation of risk perception in our model differs from these models in that it is not the perception of the risk involved in the risky decision itself, but the perception of the major farm risks in general. This is in line with a study by Bergfjord (2009) who examined the effect of perceived major sources of risk on risk management in Norwegian aquaculture. However, the lack of significance of the effect of risk perception on the risk management strategies can be due to this operationalisation of perceived risks in our model. The perceived major risks in our model do not directly relate to the risk management strategies, i.e. the strategies do not straightforwardly decrease the source of the perceived major risk, but reduce the impact on a common goal, stabilizing income and continuation of the farm. We expected that the selected perceived risks are of such an importance that they would directly influence the decision to opt for any risk management strategy. However, it is possible that these risk sources are not specific enough to trigger the implementation of any of the risk management strategies in particular.

Given the contrasting findings on the relative importance of risk perception and risk attitude on risk behaviour, we adhere to the suggestion of Keil et al. (2000) that future research should clarify this inconsistency.

Risk Attitude

Risk attitude influences three risk strategies negatively: i) to be less willing to take risk , that is risk averse, affects in a greater tendency to obtain an off-farm income, ii) to cope with risk by ad-hoc measures, and iii)to keep a financial buffer. However, risk attitude also influences three risk strategies positively, i.e. the more willing farmers are to take risks the more likely they will implement these risk strategies. We can thus classify two major risk management approaches: one for risk-averse farmers and one for farmers who are more willing to take risk.

Risk-averse farmers tend to reactively deal with risk, by for example keeping a buffer, ensuring an off-farm income or working harder and cutting private expenditure in times of hardship. Farmers who are more willing to take risk will adopt a proactive approach towards risk, using for example external risk management options, diversifying production and income sources or optimizing their farms. This finding confirms the results of a study by Hellerstein et al. (2013), who found that risk-averse farmers are less likely to diversify their operations and use contracts. Furthermore, this division is remarkably similar to the one described in the managerial literature describing differences between managers and entrepreneurs, where entrepreneurs have a higher risk attitude compared to managers (Carland et al., 2013; Stewart and Roth, 2001; Begley and Boyd, 1987), or the difference between yeoman and entrepreneurs in the farming context (Austin et al., 1996).

Hence, risk-averse farmers are less inclined to adopt ex-ante risk management strategies and rather rely on ex-post curative measures. On the contrary, the more risk taking a farmer is, the more likely that (s)he will implement ex-ante risk management strategies. One explanation for this finding is that farmers who are more willing to take risk, simply have a bigger necessity to protect themselves against these risks and thus are more inclined to adopt specific risk management strategies. This is in particular the case for external risk management strategies, as farmers can allow taking more risk while they are insured and hence are certain of a minimum price or income. In the case of optimization of the farm, it could simply be that farmers who are very risk averse, do not want to take the financial risk associated with modernizing and or scale enlargement, even if such strategies could diminish business risk and increase return. Given the complexity and interdependencies of different risks, it is often the case that the very fact of managing one risk brings about other risks (see Chapter 5). Finally, farmers are balancing risks, i.e. farmers who are more willing to take certain specific risks are at the same time managing other risks to balance total risk (de Mey et al., 2014).

Indirect determinants

The indirect effects of the socio-demographics and farm characteristics are mostly in line with previous research. One exception is the effect of age on risk perception. This was found to be significant and negative concerning production risk. It is expected that the relation between age and risk perception is mediated by a third variable that is not included in the model. For instance, it is not unlikely that older famers have higher savings and therefore perceive less risk. It could also be that older farmers have more experience with management of production risk and therefore encounter less production risk. The effect of age on attitude is significant and negative as predicted, just like the effect of farm size on risk attitude. The lack of significance for the effect of education on risk attitude is in line with the discussion in literature about the sign of this relation. Furthermore, it is in general not evident to elucidate and quantify the complex relations between farmers' characteristics and their risk attitude (Bard and Barry, 2000).

3.5.2 Limitations of the model

The lack of a significant relation between perceived risks and risk behaviour might indicate an inadequate measurement model of perceived risks. Even though confirmatory factor analysis showed a good fit for our measurement model for risk perception, it could be that the individual perceived sources of risk should not be clustered. Besides a possible validity problem for the combined items, it could also be that our measure of perceived risk, by multiplication of perceived probability and perceived impact does not generate a realistic measure. Keil et al. (2000), for instance, propose a formative model of perceived risk where probability and impact are components of a factor. Mellers and Chang (1994) give an overview of the implications of assumptions of multiplicity and addition in models of perceived risk measured with perceived probability and perceived impact.

Risk attitude is a latent construct, hence it cannot be measured directly (Reynaud and Couture, 2012). We have elucidated respondents risk attitude indirectly, based on the responses to a series of statements that are thought to be influenced by the latent construct and scored on Likert-scales, referred to as psychometric scales. This multi-item scale approach is commonly used for the purpose to elucidate risk attitude (Fausti and Gillespie, 2006), especially in the frame of a postal survey. However, there are some reservations about this method of measuring risk attitude. First, this method elucidates a self-reported risk attitude and as a consequence, is subject of a number of biases, such as strategic motives, social desirability and other self-serving bias (Dohmen et al., 2011). Second, each measure of risk attitude measures risk attitude indirectly (Reynaud and Couture, 2012) and holds only in the specific context of the measurement. Entangling risk attitude from the observed or stated behaviour, hence freeing the measure for its context is a difficult task (Just and Pope, 2003). Third, the validity of risk attitude elucidated in hypothetical settings about actual farming behaviour is questioned (Hellerstein et al., 2013). However, risk attitude elucidation from observed farm behaviour is hard given the complexity of field behaviour. This is exactly why researchers turn to experimental and survey methods (Hellerstein et al., 2013).

The dynamical interrelations between risk perception, risk attitude and risk behaviour, now and in the past, are rather complex. For example, risk perception is influenced not only by perceived past volatility but also by the possible management actions that were taken in the past (diminishing present objective risk) (Pligt, 1998). Future research should be performed to clarify these dynamic interrelations and how they affect each other over time taking a longitudinal study approach.

3.6 Conclusions

Based on literature, we developed a theoretical model for understanding the intended use of risk strategies in terms of both risk attitude and perceived risks. Empirical evidence for this model is provided by using structural equation modelling on data gathered from a survey on a large and representative sample of

farmers in the Flanders region of Belgium. The model combines risk perception and risk attitude as direct determinants of risk behaviour, while perception and attitude themselves are influenced by other variables (perceived past exposure to risk, farming attitudes, socio-demographics and farm size).

Our empirical results show that perceived major risk sources have no significant effect on the propensity to implement any risk strategy. On the other hand, risk attitude does have a significant impact. This means that risk management is not so much guided by the amount of risk faced, but rather by the attitude towards risk. Risk-averse farmers are more inclined to reactive management of risks, not coping with individual risks but allowing for them to exist and manage their impact by: (i) post hoc measures, like working harder or postponing private spending, (ii) keeping a buffer for times of hardship or (iii) ensuring an additional external (off-farm) income. On the contrary, farmers who are more willing to take risks are managing risk with a proactive attitude, trying to diminish the impact and occurrence of risk by: (i) relying on external risk management tools, such as insurances and future markets, (ii) diversifying their production and on-farm income sources or (iii) optimizing their business. These proactive strategies allow the farmer to take an entrepreneurial approach to farm management.

Our study has both practical and theoretical contributions. In terms of practical contribution for better farm risk management, the findings mentioned above have implications for researchers and policymakers willing to influence risk behaviour by means of interventions targeted at either risk attitude or risk perception. The findings of this paper may be of practical use for policymakers, producers and farm management consultants providing risk management services. It may help policymakers understand and anticipate farmers' responses to policy changes and how and why producers may combine or trade-off different risk management strategies. Our findings will help farm management consultants to better target their advice and risk management services to the personal characteristics and decision-making process of farmers.

Furthermore, our results contribute to the field of risk research by extending investigation on models that take both the perception of risk and risk attitude in account in an integrated approach to study risk behaviour.

Chapter 4

A closer look to the antecedents of intended use of individual risks strategies

Based on: van Winsen, F., 2014. Determinants of farmers' intention to use risk strategies, poster presentation at the 14th EAAE Congress, Agri-Food and Rural Innovations for Healthier Societies, August 26-29, Ljubljana.

Keywords: farm risk strategies, risk perception, risk attitude, seemingly unrelated regression (SUR)

Abstract: Among the most vital and difficult decisions farmers have to make is the decision about what risk management strategies to apply. This study simultaneously investigates the determinants of eleven different risk management strategies. The determinants are retrieved from preliminary interviews and literature study. The risk strategies are: (i) keeping a financial buffer for times of hardship, (ii) avoiding big loans and hence financial dependency, (iii) saving on private expenditure in times of hardship, (iv) working harder in times of hardship, (v) diversifying production, (vi) the use of forward contracting against price volatility, (vii) the use of insurances, (viii) technical optimization of the farm, (ix) scale enlargement of the farm, (x) diversifying income (by developing non-agricultural income sources like agro-tourism) and (xi) obtaining an off-farm income. It was found that risk attitude is a significant predictor for the intended adoption of the most strategies. The percentage of income support on the total income is, contrary to our expectations, not a significant predictor for any of the intended behaviours. Hence, no evidence for the described crowding out effect was found in this study. Furthermore, the influence of previous risk behaviour is not a good predictor for the intention to apply similar risk strategies in the future.

4.1 Introduction

The farmer's choice for different risk management tools is both complex and of major importance to the continuation of the farm business (Hansson and Lagerkvist, 2012; Velandia et al., 2009). Hence, studies investigating this choice are vital. Different studies have investigated the determinants of a single risk strategy. Predominantly, the determinants for price risk management strategies, such as future markets and forward contracting, and yield risk management by crop insurances are well investigated.

Goodwin and Schroeder (1994) examined the determinants of using forward contracts and future markets. They found risk attitude, farmers' level of education and farm size to be of significant impact on the use of contracts. Furthermore, the participation in educational programs on the use of forward-pricing techniques significantly enhanced the probability of farmers to adopt these techniques. Davis and Gillespie (2007) studied the factors that influence farmers to use contracts, work together in cooperative arrangements or enter in independent production. They found that intrinsic risk attitude had very little influence on the choice of farmers to use contracts. Instead, feeling of autonomy was found to be an important determinant, since farmers who value autonomy less were more likely to adopt contracts. Moreover, farmers adopting contracts were typically less diversified, hence experienced more business risk. Sherrick and Barry (2004) investigated the determinants of crop insurance decisions. They established that farmers who are more highly leveraged, less wealthy, riskier, and who operate larger acreages, engage more extensively in insurances. Enjolras et al. (2012) verified that the farm characteristics such as farm size and diversification were key factors in insurance decisions. Furthermore, they found that being previously insured made a farmer more likely to remain insured.

Farmers often use a set of different risk strategies together (Velandia et al. 2009). Even if some studies do investigate the determinants of the implementation of several risk strategies, e.g. the study by Mishra and El-Osta (2002) on hedging strategies and crop insurances and the study by Knight et al. (Knight et al., 1989) on crop insurances and forward contracting, these studies are not simultaneously investigating these strategies but rather in separate analyses that are discussed next to each other. It is important not only to investigate several strategies in one study but also to simultaneously investigate these strategies acknowledging the potential relations between the different adoption decisions (Velandia et al., 2009). Studies simultaneously investigating the elements causing a farmer to opt for multiple risk strategies are scarce. An exception is the study of Velandia et al. (2009) on crop insurance, forward contracting and spreading sales.

In this study, we contribute to the literature by simultaneously investigating the determinants of a range of different commonly known risk strategies, being: (i) keeping a financial buffer for times of hardship, (ii) avoiding big loans and hence financial dependency, (iii) saving on private expenditure in times of hardship, (iv) working harder in times of hardship, (v) diversifying production, (vi) the use of

forward contracting against price volatility, (vii) the use of insurances, (viii) technical optimization of the farm, (ix) scale enlargement of the farm, (x) diversifying income (by developing non-agricultural income sources like agro-tourism), and (xi) obtaining an off-farm income (by either the farm manager or the partner). To the best of our knowledge, this is the first study that looks at such a broad range of different risk strategies. The determinants of the adoption of risk strategies are based on interviews with farmers and literature study. The determinants under study include risk attitude, three socio-demographic variables, seven selected farm characteristics and three revealed (risk) management behaviours.

The data used to investigate the influence of the determinants on the different risk strategies was obtained by a survey held under a representative sample of 759 farmers from Flanders, the Northern part of Belgium. This work is contributing to the literature by (i) confronting the findings of previous studies that have investigated the determinants of risk strategies, (ii) and modelling the effects of a number of determinants of risk behaviour on a large range of multiple risk strategies simultaneously.

4.2 Risk strategies and determinants

The choice of determinants to include in our model, predicting the intended and actual adoption of risk strategies, is based on a series of preliminary interviews conducted with farmers and on previous literature investigating the determinants of either a single behaviour or multiple behaviours. A full list of both dependent and independent variables included in our study is given in Table 4.1. Below, the strategies and determinants included in our study are discussed.

4.2.1 Risk management strategies

Farmers use a wide variety of risk management strategies to deal with different risk sources. These risk management strategies can be classified in three categories: risk reduction, risk mitigation and risk coping (OECD, 2009). Risk reduction strategies are aimed at decreasing the probability of risk and include modernization or technical optimisation. Risk mitigation strategies are allowing risk to happen but mitigate the impact. Examples of such strategies include farm diversification and strategies that transfer the risk away from the farm like the use of forward contracts or insurances. Finally, risk coping strategies are strategies that allow coping with the risk and/or the restoration of damage, like obtaining an off-farm income or cutting on private expenditure.

Alternatively, the strategies included in this study can be divided in reactive and active strategies to manage risk (see Chapter 3). The reactive risk management strategies do not require pre-emptive planning and management of risk, but rather are a reaction to the occurrence of risk or a general precaution towards no specific risk in particular. This category of risk strategies includes: obtaining an off-farm income (by either the farm manager or the partner), keeping a financial buffer for

times of hardship, avoiding big loans and financial dependency, saving on private expenditure in times of hardship and working harder in times of hardship.

Table 4.1: An overview of the risk strategies and the determinants used in this study

Name	*Description*	Range	Mean
Dependent variables *			
Reactive risk management			
Buffer	Keeping a financial buffer for times of hardship	1-5	4.07
Avoiding loans	Avoiding big loans and financial dependency	1-5	3.23
Saving	Saving on private expenditure in times of hardship	1-5	3.63
Hard work	Working harder in times of hardship	1-5	3.10
Off-farm	Obtaining an off-farm income (by either the farm manager or the partner)	1-5	2.56
Proactive Risk management			
Prod. Div.	Diversifying production	1-5	3.07
Contracts	The use of forward contracting against price volatility	1-5	2.69
Insurances	The use of insurances	1-5	2.56
Invest Techn.	Technical optimization on the farm	1-5	3.53
Scale	Scale enlargement	1-5	3.02
Diversify	Diversifying income (by developing non-agricultural income sources like agro-tourism)	1-5	2.58
Independent variables **			
Socio-Psychological characteristic			
Risk attitude	A proxy of (financial) risk attitude measured with 9 items, alpha = 0.73	1 – 4.56	2.76
Socio-demographics			
Age	The age of the farmer	29-71	50
Education level	1 = elementary, 2 = lower technical of vocational , 3 = college or university level	1-3	2.12
Education specialization	1 = Farmer had no specialisation in agriculture 2 = farmer specialised on agriculture in his formal education	1-2	1.65
Farm characteristics			
NOI (mean)	Mean Net Operating Income over the years 2010-2012 (in thousand euro)	0.7-842	100
NOI (COV)	Coefficient of variation of the Net Operating Income over the years 2010-2012 (in thousand euro)	0.02-1.24	0.34
Solvability	Debt to asset ratio	0-100%	25%
Subsidy	Percentage of subsidy received on the total Net Operating Income	0-952%	40%
Tenure	Percentage of owned acreage on the total cultivated land	0-100%	39%
Farm-cycle	1 = starting, 2 = settled and growing, 3 = settled and stable, 4 = preparing for takeover, 5 = winding down for pension.	1-5	N.A.
Typology	Type of the farm based on the FADN farm-typology: 1 = horticulture, 2 = permanent crops, 3 = grazing livestock non dairying, 4 = granivore, 5 = mixed cropping, 6 = mixed livestock, 7 = mixed crops-livestock, 8 = specialist dairying	1-6	N.A.
Region	1 = sandy, 2 = Kempen, 3 = sand-loamy, 4 = loamy, 5 = meadow	1-5	N.A.
Past Risk Management			
Diversification	A proxy for the farm income diversification based on Hirschdale index	11-100%	48%
Off-farm income	0= no off-farm income, 1 = off-farm income by either the farm-manager or his/her partner.	0-1	0.3
Insurances	Percentage of cost for insurance on the total farm cost	0-7%	1%

n = 608; * All dependent variables are measured with a survey administrated in 2013. ; **All independent variables are calculated using the FADN data of the year 2012 unless mentioned otherwise and with the exception of risk attitude that was also measured with the survey data of 2013.

The proactive risk management strategies do require planning and a hands-on attitude. This category of strategies includes: diversifying production, the use of forward contracting against price volatility, the use of insurances, technical optimization of the farm, scale enlargement of the farm, and diversifying income (by developing non-agricultural income sources like agro-tourism).

Many strategies that farmers mentioned in the preliminary interviews are protecting them against financial risk, i.e. the risk of not being able to pay back debts in time. Keeping a buffer is a very straightforward strategy and also involves keeping a financial safeguard for times when a big investment needs to be made. In line with this strategy is the intention to avoid loans. In the preliminary interviews, it appeared that many farmers are consciously avoiding loans in order to avoid financial risk, and consequently deprive themselves from possible opportunities to grow in size or modernize the farm. A third strategy that protects against financial risks is saving on private expenditure. A fourth strategy is to work harder to generate more income in times of financial hardship. Finally, financial risk can also be decreased by obtaining an off-farm income.

Enlarging the farm might not directly seem like a risk management strategy. However, from the interviews, we learned that sometimes farmers choose to deliberately enlarge their farm in order to sustain profitability with respect to possible decreasing profit margins. In this regard, a strategy is purposely chosen in order to be able to absorb future shocks in prices considering dropping margins. Other studies have also stressed the importance of growth in farm management (e.g. Weiss, 1999). Similarly, specialization or modernization is also seen as risk management, i.e. gain in efficiency in order to cope with future shocks (Kelly et al., 2013; Mugera and Langemeier, 2011).

Diversification is a strategy that farmers can implement to manage volatility in prices and possible losses in production, by diminishing their dependency on just a few main products. Hence, diversification is a straightforward risk reducing strategy (Hellerstein et al., 2013). Crop insurances are used to diminish yield risk by protecting against yield losses due to, for example, climatic conditions or diseases.

4.2.2 Determinants of risk management

The determinants (of the intention to choose the described risk strategies) that we selected to include in our study can be divided in socio-psychological, socio-demographical, farm and risk management characteristics.

The socio-psychological characteristic that we included as determinant for risk strategies is risk attitude. Risk attitude is a measure about to what extent a person is willing to take risk or to avoid risks. A higher risk attitude means a higher willingness to take risk and therefore a lesser likelihood to implement risk strategies (Chavas et al., 2010). Hence, risk attitude is expected to have a negative influence on both the intended and actual adoption of risk management strategies.

The socio-demographic variables that we include in this study are age and education. Both these variables have been studied as determinants for the adoption of a variety of different farm risk management strategies, such as the use of crop insurance (Velandia et al., 2009; Sherrick and Barry, 2004; Knight et al., 1989), forward contracting (Velandia et al., 2009; Knight et al., 1989), spreading sales (Velandia et al., 2009) and hedging or the use of future markets (Shapiro and Brorsen, 1988).

The variables that are of particular interest in this study are the farm characteristics: net operating income, the coefficient of variation of net operating income, solvability, tenure, farm-typology and geological region. Net operating income is a proxy for the economic size of the farm.

4.3 Data and methods

Data was collected by combining a postal survey with the accountancy data of the FADN-network of Flanders (in Belgium). Below we describe the data collection and the statistical method used.

4.3.1 Survey

In March 2013, we sent the survey to 759 farmers, covering the entire FADN sample of Flanders (Belgium). In April 2013, we recollected about 624 surveys, representing a response rate of 82%. Data cleaning, in which surveys were removed if they contained over 25% of missing value (n=10) and/or if the farm was not represented for at least 3 executive years ending in 2012 in the FADN data set (n=6), left us with 608 surveys. Finally, in our analysis, we used list wise deletion of cases, leaving 352 surveys with no missing data and representing an effective response rate of 46%. Comparison of our final sample with the total FADN sample did not show any significant bias towards age and farm type and hence we can conclude that our sample is representative for the farmer population in Flanders.

The survey contained Likert-type items about the farmers' risk perceptions, risk attitudes and intended risk strategies. The farmers were asked to score these questions on a five point scale. For risk perception, we asked the farmer to score nine different risk sources concerning their perceived probability of occurrence (low probability to high probability), the impact if occurring (low impact to high impact) and the influence they have on the occurrence of the risk (low influence to high influence). The nine risk sources, selected based on literature review and interviews with famers, were: (i) loss of production due to (extreme) weather conditions, (ii) loss of production due to disease (epidemic), (iii) extraordinary low market prices, (iv) extraordinary high cost prices, (v) too little revenues considering the costs over a long time period, (vi) unexpected changes in regulation with negative impact on the farm, (vii) limited access to land, or too high prices for land, (viii) personal problems resulting in a negative impact on the company and (ix) cancellation of (an important share of) the subsidies. Risk attitude was measured with nine statements regarding (financial risk) taking (scored from strongly disagree to strongly agree). This method was adopted from the risk attitude scale developed by Bard and Barry (2000).

In order to assess intended use of the different risk strategies, we asked the farmers to score to what extent they considered implementation of 11 different risk management tools a (possible) aid against financial uncertainty at their farm (very implausible to very plausible). The list of risk management tools was based on interviews with farmers and consisted of: (i) keeping a financial buffer, (ii) diversifying in production, (iii) investing in non-farm assets (tourism, farmers market), (iv) forward contracting, (v) obtaining an off-farm income, (vi) investing in technical optimization of farm, (vii) investing in scale enlargement, (viii) working harder in times of financial uncertainty, (ix) postponing private purchases, (x) obtaining (non-obligatory) insurances, (xi) avoiding big loans at the bank.

4.3.2 FADN-data

The data from the survey was complemented with the data from the local FADN data set. This allowed us to link individual's intended behaviour, the perceived risks and risk attitude with socio-demographic data (e.g. age, education), farm characteristics (e.g. farm type), farm economic data and observed strategies (e.g. percentage of cultivated land under contract). The FADN-data set contains accountancy data up to the year 2012 and we used the data for 2012 unless stated differently. This also means that we have a time lag of one year between the survey data and the FADN data. Since our endogenous variables (the intended risk strategy) are from 2013 this does not pose a problem. Hence, observed risk strategies in the year 2012, like use of contracts, can be a predictor variable for the intention to use forward contracts in 2013. A complete list of variables under study is given in Table 4.1. Below, we describe how the less straightforward variables were derived, i.e. what are their constituencies.

We opted to include past use of risk strategies as predictor for current intention to use risk strategies. The actual, or revealed, use of risk strategies that we could operationalise from the FADN-data set are: income diversification, use of contracts, use of insurances, obtained off-farm income and solvability. We created a proxy for the diversification of the farm income using a Herfindahl-Hirchman Index (HHI). This index, which originated as a market share index (Hirschman, 1964), sums the squared share of the individual income sources on total income (equation 4.1):

$$D = \sum_{i=1}^{N} \left(\frac{I_i}{T}\right)^2 \qquad [4.1]$$

In which D is the HHI or diversification index, I_i is the income from income source i, N is the total number of different income sources and T is the total income. This index is an indication of ratios of income and can obtain value ranging from 1 (not diversified at all) to close to 0 (diversified to a great extent). The FADN data allows tracking the income source because income of all the different crops or animal products produced at the farm, as well as the ones derived from non-farming activities like farm-tourism, are separately accounted for.

The revealed behaviour on use of contracts is calculated as a percentage of the cultivated land under contract out of the total cultivated land. The use of insurance

is operationalised as the cost spent on insurances as percentage of the total cost. Off-farm income is operationalised as a dummy variable in which the farmers who have an off-farm income (either because they work part-time off-farm or their spouse does) and the farmers who do not have an off-farm income. Solvability is the debt-to-asset ratio.

Next to the revealed behaviours, we include several farm characteristics as predictor variables for the intended use of risks strategies. The farm typology we use is based on the FADN SO-typology and includes: specialist field crops, specialist horticulture, specialist permanent crops, specialist grazing livestock non-dairy, specialist dairy, specialist granivores, mixed cropping, mixed livestock and mixed crops-livestock. The region of study is Flanders, the northern region of Belgium. The agricultural areas in this region are classified as: sandy, loamy, sand-loamy, meadow, polder and the Kempen, the latter is a specific area in North Flanders and the south of The Netherlands which is characterized by sandy soils. The farm cycle is a categorical variable that can be compared to business stage. The farmers are asked which of the following categories best describes the situation on their farm: starting, settled and growing, settled and stable, preparing for takeover or preparing for pension. We use Net Operating Income (NOI) as a variable reflecting the income derived from the farm. The coefficient of variation of NOI over a time span of 3 years (2010-2012) is a measure for the volatility of the income and is a proxy for the business risk. The amount of total subsidies received on the farm as percentage of the total NOI is given in the variable subsidy. Tenure is a variable that specifies the percentage of land owned on the total area cultivated, which is important because land is one of the most important source of capital for farming.

Finally, we include some of the farmers' characteristics in our model. The level of education is a categorical variable and classifies the farmer with a lower than high school education, high school diploma, undergraduate and graduate level. Furthermore, we separate between farmers who had a specialization (or major) in agriculture during their studies and farmers who had not.

4.3.3 Model specification

We assess the impact of the mentioned determinants on the mentioned intended risk behaviour assuming a linear relationship:

$$y_n = \beta_{n,j} x_{n,j} + \varepsilon_n \qquad [4.2]$$

In which y_n represent each of the, in total n number of, strategies, $\beta_{n,j}$ represents each of the, in total j number of, coefficient vectors of the explanatory variables $x_{n,j}$, and ε_n symbolize the idiosyncratic error. As mentioned above, farmers are expected to opt for a mixture of risk management strategies and we expect that the intended risk strategies are correlated. In estimating the impact of the determinants on the risk strategies, we take this correlations into account, by allowing the error terms of the regression equations (one for each risk strategy) to be correlated in a seemingly unrelated regression model (SUR). In this way, we can estimate the regressors more

efficiently (with lower standard errors) than with an equation-by-equation approach (Zellner, 1962).

SUR is an estimation method for a set of different linear equations in which a correction for contemporaneous correlation of the error terms is performed and can be described as:

$$\begin{pmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{pmatrix} = \begin{pmatrix} X_1 & 0 & \cdots & 0 \\ 0 & X_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X_n \end{pmatrix} \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{pmatrix} + \begin{pmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{pmatrix} \quad [4.3]$$

In which y_1 to y_n are the intended behaviour under study, X_1 to X_n represent the list of predictor variables, $ß_1$ to $ß_n$ the corresponding beta coefficients and ε_1 to ε_n represent the residuals of each equation.

Since this method allows estimating the whole system of equations, an enhanced efficiency for the estimation of the regressors can be obtained. However, the increased efficiency of SUR comes with the cost of low robustness. Potential heteroscedasticity can cause wrong error terms and hence false confidence in the estimates. In order to overcome this problem, we compare our results with a seemingly unrelated estimator model (SUEST), based on the Eicker-Huber-White-sandwich covariance estimator (White, 1980; Huber, 1967; Eicker, 1963). This approach has a higher robustness and has heteroscedasticity robust standard errors, but this approach is less efficient compared to the SUR model. Both the SUR model and SUEST models were estimated using the statistical package STATA (StataCorp, 2011).

4.4 Results and discussion

The mean values and the standard deviations of our dependent variables are shown in Table 4.2. The values presented here might slightly differ from the values presented in Chapter 2, since, for the calculation of mean and standard deviation, only those data are used for which no missing data in any of the variables under study was present. However, we see the same order of importance as described in Chapter 2. The strategies that are considered as most likely to be adopted are: keeping a buffer, saving on private expenditure and investing in technologies, while the more classic strategies insurances and contracts are scored lower, i.e. indicated as less likely to be adopted. The use of futures is not included in this study as futures are not commonly used in Belgium and are only available for very few commodities (Meuwissen et al., 2008).

Table 4.2: The intended use of the different risk strategies

Variable	Mean	Std. Dev.
Maintain financial buffer	4.02	0.85
Cut private spending	3.76	1.04
Technological optimization	3.55	0.91
Debt management	3.32	1.12
Work hard in difficult times	3.19	1.03
On-farm diversification	3.10	0.97
Scale enlargement	2.99	1.11
Contracts	2.77	1.13
Off-farm income	2.65	1.38
Income diversification	2.64	1.25
Extra-legal insurances	2.59	0.96

n = 614

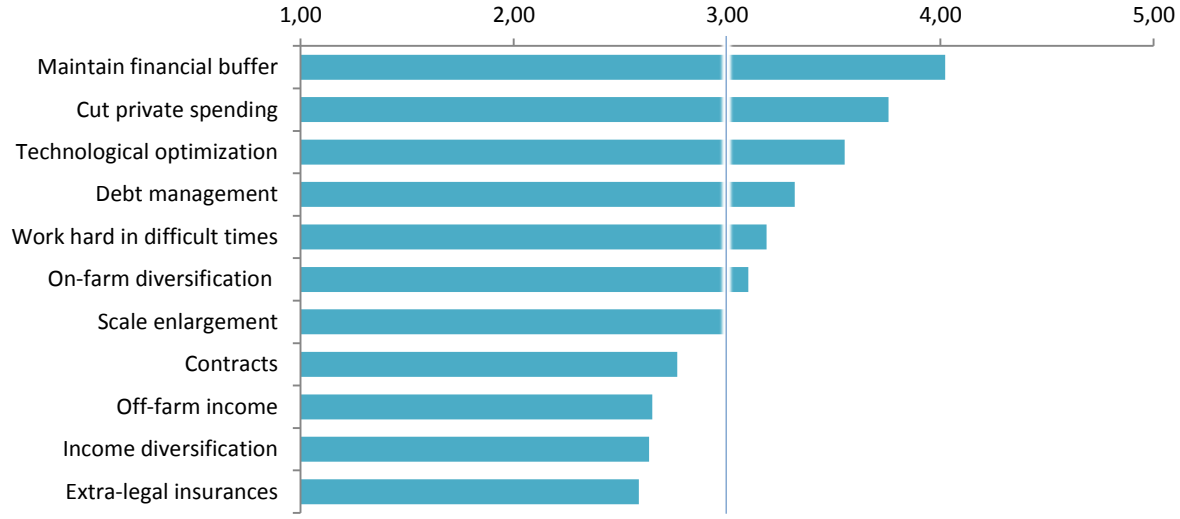

Figure 4.1: The intended use of the different risk strategies, n=614

The choice of risk strategies is made considering the intended use of other risk strategies so the choice for one can inhibit the other, an effect known as crowding out (Kimura et al., 2010). Indeed, Pearson's pair-wise correlation of the intended risk strategies indicated that the majority of the strategies are correlated with each other (Table 4.3). On the one hand, we expect crowding out effects, implying that having a higher intention for using one risk strategy would lower the intention to use an alternative risk management strategy, so a negative correlation can be expected. On the other hand, there will be an individual or farmer effect, that is one farmer, perhaps because he is more risk averse, would be more tended to use risk strategies in general, and therefore a positive correlation can be expected. The biggest significant ($p>0.05$) positive correlation coefficients are between investing in modernization and scale enlargement (0.46, p-value < 0.01), hard work and saving on private expenditure (0.38, p-value < 0.01) and income diversification and product diversification (0.38, p-value < 0.01). These high positive pairwise correlations indicate that, rather than crowding each other out, these might be complementary to each other. The largest significant ($p>0.05$) negative correlation coefficients is found between enlargement and avoiding loans (-0.17, p-value < 0.01). This negative correlation could be expected given the typical large cost involved in scale enlargement and the generally associated large loans. However,

this is the only negative correlation with a correlation coefficient of over -0.10, and therefore the data does not provide evidence for crowding out effects between the intended strategies. Our finding that the intended use of one risk management tool is positively associated with the intended use of other risk management tools is similar to the findings of Velandia et al. (2009) who looked at the simultaneous decision to adopt crop insurance, forward contracting, and spreading sales. In this study, we confirm this finding and generalize it to a wider set of strategies that are less obviously connected.

Table 4.3: Correlations between the intended risk strategies, coefficients are printed above the p-values, bold indicates p-value < 0.10

	Buffer	**Avoid**	**Saving**	**Hard work**	**Prod. Div.**	**Contract**	**Insur.**	**Invest. Techn.**	**Enlarge**	**Income Div.**	**Off-farm**
Buffer	1										
Avoid loans	**0.13**	1.00									
	0.00										
Saving on private	**0.10**	**0.21**	1.00								
	0.01	**0.00**									
Hard work	0.04	**0.08**	**0.38**	1.00							
	0.35	**0.04**	**0.00**								
Prod. Div.	0.06	**0.10**	**0.07**	**0.07**	1.00						
	0.14	**0.02**	**0.07**	**0.08**							
Contracts	-0.02	0.02	0.02	**0.07**	**0.11**	1.00					
	0.64	0.68	0.70	**0.10**	**0.01**						
Insurances	**-0.09**	-0.01	**0.17**	**0.12**	0.06	**0.16**	1.00				
	0.02	0.88	**0.00**	**0.00**	0.14	**0.00**					
Invest. Techn.	**0.09**	-0.05	**0.11**	**0.18**	**0.23**	**0.10**	**0.12**	1.00			
	0.03	0.20	**0.01**	**0.00**	**0.00**	**0.02**	**0.00**				
Enlarge	0.04	**-0.17**	0.04	**0.20**	**0.19**	**0.10**	**0.16**	**0.46**	1.00		
	0.34	**0.00**	0.31	**0.00**	**0.00**	**0.01**	**0.00**	**0.00**			
Income Div.	**-0.07**	0.02	0.00	0.01	**0.38**	**0.12**	**0.16**	0.04	0.03	1.00	
	0.10	0.67	1.00	0.81	**0.00**	**0.00**	**0.00**	0.39	0.51		
Off-farm	**-0.07**	**0.20**	**0.10**	0.06	0.02	**0.11**	**0.13**	**-0.07**	-0.05	**0.22**	1.00
	0.09	**0.00**	**0.02**	0.17	0.69	**0.01**	**0.00**	**0.07**	0.21	**0.00**	

n = 364

In Table 4.4 and Table 4.5, the coefficients and p-values of the regressors in both the SUR and SUEST model are presented. The Breusch-Pagan test for independent equations indicated that the error terms were significantly correlated, hence a system of equations approach is in place. The variance inflation factors (VIF) are all below 3 indicating no issue with multi-collinearity between the determinants. However, a low significance of the Breusch-Pagan test for the independent variables does indicate heteroscedasticity, therefore the results of the SUR regression should be treated with care and always compared with the robust SUEST model. Both the SUEST and the SUR model showed a few significant determinants for the risk strategies under study. Not a single variable is significant across all the strategies. Below, we will discuss the significant variables.

Table 4.4: Parameter estimates from the SUR model

	Buffer	**Avoid Loans**	**Saving**	**Hard Work**	**Prod. Div.**	**Contracts**	**Insurances**	**Inv. Tech.**	**Enlarge**	**Income Div.**	**Off-farm**
Risk Attitude	**-0.30 (0.00)**	**-0.60 (0.00)**	**-0.52 (0.00)**	-0.13 (0.20)	**0.26 (0.01**)	-0.01 (0.93)	0.08 (0.39)	**0.28 (0.00)**	**0.31 (0.00)**	**0.27 (0.02)**	-0.15 (0.20)
Age	-0.01 (0.27)	-0.01 (0.45)	-0.01 (0.35)	0.00 (0.89)	-0.01 (0.17)	0.00 (0.82)	-0.01 (0.16)	0.00 (0.91)	**-0.02 (0.03)**	0.00 (0.76)	0.01 (0.35)
Education Lvl. (*elementary)*											
lower technical / vocational	0.40 (0.23)	0.31 (0.48)	-0.47 (0.29)	-0.12 (0.78)	-0.03 (0.95)	0.16 (0.72)	0.38 (0.33)	0.76 (0.03)	0.35 (0.37)	0.02 (0.98)	-0.47 (0.36)
college or university level	0.55 (0.11)	0.16 (0.72)	-0.63 (0.17)	-0.2 (0.66)	-0.01 (0.98)	0.13 (0.79)	0.27 (0.52)	0.82 (0.03)	0.21 (0.61)	0.17 (0.76)	-0.43 (0.43)
Education Spec. (*none*)											
agricultural specialisation	0.10 (0.28)	-0.02 (0.89)	0.16 (0.20)	**0.23 (0.05)**	-0.02 (0.85)	0.13 (0.31)	-0.08 (0.46)	-0.09 (0.33)	0.06 (0.61)	0.14 (0.32)	-0.12 (0.40)
Farm Cycle (*starting*)											
settled and growing	-0.52 (0.19)	0.2 (0.71)	0.32 (0.54)	-0.41 (0.41)	-0.51 (0.29)	-0.02 (0.97)	0.12 (0.8)	-0.41 (0.33)	0.80 (0.09)	-1.05 (0.09)	0.23 (0.71)
settled and stable	-0.52 (0.20)	0.14 (0.79)	0.14 (0.79)	**-0.98 (0.05)**	-0.75 (0.12)	-0.18 (0.74)	0.20 (0.66)	-0.79 (0.06)	-0.13 (0.78)	-0.94 (0.13)	0.48 (0.44)
preparing for takeover	-0.70 (0.12)	-0.09 (0.88)	0.15 (0.80)	-0.43 (0.46)	-0.42 (0.45)	0.19 (0.77)	0.61 (0.25)	-0.66 (0.17)	0.38 (0.48)	-1.07 (0.13)	0.67 (0.34)
preparing for pension.	-0.44 (0.32)	-0.11 (0.85)	0.47 (0.42)	-0.78 (0.16)	-0.47 (0.38)	-0.18 (0.76)	0.22 (0.67)	-0.88 (0.06)	-0.08 (0.88)	-0.77 (0.25)	0.4 (0.56)
Solvability	-0.36 (0.12)	**-0.96 (0.00)**	**0.69 (0.03)**	0.12 (0.69)	-0.09 (0.75)	0.75 (0.02)	0.70 (0.01)	0.54 (0.03)	0.49 (0.08)	0.45 (0.22)	0.65 (0.08)
NOI	**0.00 (0.01)**	0.00 (0.68)	0.00 (0.24)	0.00 (0.22)	0.00 (0.33)	0.00 (0.12)	0.00 (0.28)	0.00 (0.14)	0.00 (0.09)	**0.00 (0.02)**	**0.00 (0.01**)
NOI COV	-0.13 (0.53)	-0.56 (0.04)	0.26 (0.35)	0.49 (0.06)	-0.24 (0.34)	-0.57 (0.05)	0.11 (0.64)	-0.18 (0.41)	0.43 (0.08)	-0.04 (0.90)	0.05 (0.87)
Subsidy	0.02 (0.78)	0.07 (0.45)	0.06 (0.52)	0.03 (0.74)	0.01 (0.92)	-0.03 (0.74)	-0.04 (0.65)	0.10 (0.16)	-0.07 (0.40)	0.06 (0.59)	0.08 (0.46)
Tenure	-0.12 (0.48)	-0.11 (0.64)	0.36 (0.12)	0.06 (0.77)	-0.14 (0.51)	0.11 (0.63)	-0.06 (0.78)	-0.09 (0.63)	**0.43 (0.03)**	0.30 (0.26)	-0.27 (0.32)
Diversification	0.18 (0.42)	0.31 (0.29)	-0.13 (0.65)	0.30 (0.29)	-0.24 (0.38)	-0.45 (0.14)	-0.30 (0.26)	0.22 (0.36)	-0.15 (0.56)	-0.60 (0.08)	-0.26 (0.45)
Insurance	3.96 (0.54)	-2.69 (0.76)	-3.41 (0.70)	11.42 (0.17)	-7.56 (0.34)	-2.12 (0.81)	15.76 (0.04)	-6.99 (0.31)	-5.08 (0.51)	-0.69 (0.95)	-1.62 (0.87)
Off-farm (*none*)											
off-farm income	0.07 (0.48)	0.23 (0.08)	0.17 (0.20)	-0.02 (0.89)	0.11 (0.36)	**0.46 (0.00)**	0.21 (0.07)	0.09 (0.38)	0.00 (1.00)	0.29 (0.06)	**1.11 (0.00)**
Typology (*field* crops)											
horticulture	-0.11 (0.58)	-0.09 (0.73)	0.26 (0.34)	0.36 (0.15)	0.19 (0.44)	-0.29 (0.28)	0.02 (0.92)	-0.17 (0.41)	-0.32 (0.17)	-0.13 (0.67)	-0.18 (0.55)
permanent crops	0.02 (0.92)	-0.26 (0.40)	0.57 (0.07)	0.40 (0.18)	-0.21 (0.47)	**-0.92 (0.00)**	0.27 (0.33)	-0.09 (0.71)	**-0.94 (0.00)**	0.02 (0.96)	0.13 (0.71)
grazing livestock	-0.16 (0.40)	0.00 (1.00)	0.23 (0.36)	**0.48 (0.05)**	**-0.45 (0.05)**	-0.16 (0.53)	-0.18 (0.41)	-0.19 (0.34)	-0.08 (0.74)	**-0.76 (0.01)**	-0.26 (0.37)
granivore	0.03 (0.89)	-0.13 (0.60)	0.41 (0.11)	**0.50 (0.04)**	-0.15 (0.51)	-0.15 (0.57)	-0.2 (0.38)	-0.21 (0.30)	**-0.62 (0.01)**	**-0.60 (0.04)**	-0.15 (0.62)
Mixed cropping	-0.15 (0.68)	0.39 (0.40)	0.40 (0.40)	**1.13 (0.01)**	0.38 (0.38)	**-1.00 (0.04)**	0.32 (0.44)	0.01 (0.98)	-0.77 (0.06)	0.11 (0.84)	0.20 (0.72)
Mixed livestock	-0.1 (0.63)	-0.25 (0.35)	0.13 (0.64)	**0.64 (0.01)**	-0.39 (0.11)	0.09 (0.74)	0.07 (0.77)	-0.28 (0.19)	-0.09 (0.70)	**-0.96 (0.00**)	0.08 (0.80)
Mixed crops-livestock	-0.09 (0.64)	-0.19 (0.47)	0.35 (0.19)	0.45 (0.07)	-0.23 (0.33)	-0.17 (0.52)	-0.04 (0.87)	-0.27 (0.20)	-0.06 (0.78)	-0.57 (0.06)	-0.21 (0.48)
Specialist dairying	-0.01 (0.97)	-0.22 (0.41)	0.41 (0.11)	0.45 (0.07)	-0.20 (0.41)	-0.20 (0.46)	-0.22 (0.33)	-0.13 (0.53)	0.1 (0.68)	-0.37 (0.22)	0.04 (0.89)
Geo. Region (sandy)											
Kempen	0.04 (0.81)	-0.11 (0.66)	**0.56 (0.02)**	0.31 (0.17)	0.44 (0.04)	-0.11 (0.64)	-0.3 (0.16)	0.03 (0.88)	0.28 (0.19)	-0.16 (0.56)	-0.06 (0.83)
sand-loamy	-0.05 (0.83)	0.1 (0.72)	0.28 (0.30)	0.02 (0.93)	0.07 (0.78)	-0.16 (0.57)	-0.25 (0.30)	-0.24 (0.27)	-0.25 (0.30)	0.23 (0.47)	-0.27 (0.39)
loamy	-0.02 (0.86)	0.06 (0.71)	0.21 (0.22)	-0.04 (0.78)	0.07 (0.64)	-0.06 (0.73)	-0.29 (0.05)	0.03 (0.79)	-0.04 (0.77)	-0.19 (0.33)	-0.08 (0.69)
meadow	-0.10 (0.41)	-0.18 (0.28)	0.21 (0.21)	-0.21 (0.18)	-0.10 (0.51)	-0.07 (0.68)	-0.24 (0.11)	-0.01 (0.93)	-0.21 (0.16)	-0.17 (0.4)	0.00 (0.99)
Cons.	**5.27 (0.00)**	**5.25 (0.00)**	**4.7 (0.00)**	**3.27 (0.00)**	**4.07 (0.00)**	**2.74 (0.01)**	**2.3 (0.01)**	**2.68 (0)**	**2.4 (0.01)**	**3.19 (0.00)**	**2.69 (0.02)**
R^2	0.11	0.19	0.14	0.15	0.11	0.4	0.14	0.20	0.37	0.12	0.25

n = 364 ; p-value between brackets; bold = p

Table 4.5: Parameter estimates from the the SUEST model

	Buffer	**Avoid Loans**	**Saving**	**Hard Work**	**Prod. Div.**	**Contracts**	**Insurances**	**Inv. Tech.**	**Enlarge**	**Income Div.**	**Off-farm**
Risk Attitude	**-0.32 (0.00)**	**0.29 (0.01)**	**0.25 (0.05)**	0.00 (0.97)	-0.16 (0.19)	**0.29 (0.00)**	**0.35 (0.00)**	-0.12 (0.29)	**-0.53 (0.00)**	0.04 (0.66)	**-0.59 (0.00)**
Age	-0.01 (0.22)	-0.01 (0.14)	0.01 (0.49)	0.00 (0.79)	0.01 (0.25)	0.00 (0.84)	**-0.02 (0.02)**	0.00 (0.71)	-0.01 (0.42)	-0.01 (0.41)	-0.01 (0.56)
Education Lvl. (*elementary)*											
lower technical / vocational	0.40 (0.15)	0.00 (1.00)	0.01 (0.99)	0.20 (0.66)	-0.46 (0.32)	0.76 (0.06)	0.35 (0.33)	-0.08 (0.84)	-0.44 (0.25)	0.43 (0.20)	0.36 (0.42)
college or university level	0.56 (0.06)	0.01 (0.99)	0.17 (0.74)	0.22 (0.65)	-0.41 (0.40)	**0.79 (0.05)**	0.23 (0.55)	-0.19 (0.65)	-0.58 (0.16)	0.35 (0.33)	0.22 (0.65)
Education Spec. (*none*)											
agricultural specialisation	0.11 (0.26)	-0.05 (0.67)	0.16 (0.24)	0.10 (0.41)	-0.13 (0.33)	-0.08 (0.39)	0.04 (0.74)	**0.23 (0.05)**	0.13 (0.29)	-0.09 (0.41)	-0.05 (0.68)
Farm Cycle (*starting*)											
settled and growing	**-0.53 (0.02)**	-0.53 (0.30)	**-1.00 (0.03)**	0.00 (1.00)	0.27 (0.64)	-0.44 (0.20)	**0.80 (0.02)**	-0.43 (0.26)	0.35 (0.36)	0.15 (0.42)	0.25 (0.47)
settled and stable	**-0.58 (0.01)**	-0.71 (0.17)	**-0.92 (0.04)**	-0.13 (0.87)	0.50 (0.39)	**-0.80 (0.02)**	-0.10 (0.79)	**-0.99 (0.01)**	0.15 (0.70)	0.19 (0.29)	0.22 (0.53)
preparing for takeover	**-0.76 (0.04)**	-0.39 (0.52)	**-1.10 (0.04)**	0.18 (0.84)	0.63 (0.35)	-0.65 (0.15)	0.44 (0.32)	-0.42 (0.37)	0.14 (0.78)	0.60 (0.10)	-0.01 (0.99)
preparing for pension.	-0.54 (0.06)	-0.46 (0.40)	-0.87 (0.10)	-0.19 (0.82)	0.52 (0.39)	**-0.89 (0.02)**	-0.06 (0.89)	-0.69 (0.11)	0.50 (0.24)	0.24 (0.34)	0.04 (0.92)
Solvability	-0.38 (0.10)	-0.07 (0.80)	0.49 (0.20)	**0.78 (0.01)**	0.61 (0.09)	**0.55 (0.03)**	0.49 (0.06)	0.11 (0.74)	**0.69 (0.03)**	**0.76 (0.01)**	**-0.91 (0.01)**
NOI	**0.00 (0.00)**	0.00 (0.45)	0.00 (0.03)	0.00 (0.12)	**0.00 (0.00)**	**0.00 (0.04)**	0.00 (0.12)	0.00 (0.22)	0.00 (0.17)	0.00 (0.24)	0.00 (0.83)
NOI COV	-0.10 (0.62)	-0.17 (0.52)	-0.05 (0.88)	-0.46 (0.12)	0.09 (0.76)	-0.15 (0.49)	0.40 (0.10)	0.53 (0.04)	0.25 (0.33)	0.05 (0.83)	**-0.61 (0.02)**
Subsidy	0.02 (0.72)	0.00 (0.97)	0.05 (0.75)	-0.04 (0.54)	0.08 (0.56)	**0.09 (0.05)**	-0.06 (0.27)	0.02 (0.73)	0.06 (0.26)	-0.03 (0.52)	0.07 (0.14)
Tenure	-0.07 (0.68)	-0.08 (0.68)	0.25 (0.32)	0.09 (0.68)	-0.25 (0.35)	-0.05 (0.77)	0.42 (0.04)	0.10 (0.66)	0.33 (0.13)	-0.13 (0.53)	-0.17 (0.48)
Diversification	0.15 (0.47)	-0.31 (0.30)	-0.60 (0.10)	-0.45 (0.18)	-0.21 (0.53)	0.19 (0.43)	-0.16 (0.55)	0.25 (0.38)	-0.14 (0.68)	-0.31 (0.26)	0.26 (0.41)
Insurance	4.08 (0.48)	-4.76 (0.52)	-0.38 (0.97)	-0.42 (0.97)	-3.05 (0.73)	-5.39 (0.47)	-3.66 (0.62)	11.80 (0.17)	-5.26 (0.49)	13.40 (0.10)	-3.62 (0.70)
Off-farm (*none*)											
off-farm income	0.05 (0.60)	0.11 (0.34)	0.27 (0.06)	**0.40 (0.00)**	**1.11 (0.00)**	0.10 (0.28)	-0.03 (0.81)	-0.01 (0.92)	0.14 (0.26)	0.20 (0.10)	0.20 (0.10)
Typology (*field* crops)											
horticulture	-0.11 (0.57)	0.21 (0.35)	-0.11 (0.73)	-0.33 (0.27)	-0.14 (0.65)	-0.17 (0.44)	-0.36 (0.18)	0.43 (0.11)	0.26 (0.32)	0.01 (0.98)	-0.08 (0.75)
permanent crops	-0.05 (0.80)	-0.19 (0.52)	0.09 (0.82)	**-0.98 (0.00)**	0.18 (0.66)	-0.12 (0.62)	-0.91 (0.00)	0.38 (0.18)	**0.57 (0.04)**	0.24 (0.42)	-0.23 (0.44)
grazing livestock	-0.20 (0.31)	**-0.46 (0.03)**	**-0.74 (0.02)**	-0.18 (0.52)	-0.20 (0.54)	-0.20 (0.34)	-0.08 (0.79)	0.47 (0.07)	0.21 (0.44)	-0.22 (0.32)	-0.04 (0.86)
granivore	0.02 (0.93)	-0.16 (0.45)	-0.57 (0.08)	-0.20 (0.51)	-0.05 (0.88)	-0.22 (0.31)	**-0.65 (0.01)**	**0.50 (0.04)**	0.40 (0.11)	-0.23 (0.31)	-0.15 (0.59)
Mixed cropping	-0.18 (0.65)	0.33 (0.39)	0.16 (0.75)	**-1.06 (0.01)**	0.21 (0.74)	-0.01 (0.98)	-0.78 (0.13)	**1.09 (0.00)**	0.37 (0.31)	0.29 (0.36)	0.34 (0.35)
Mixed livestock	-0.07 (0.69)	-0.40 (0.08)	**-0.94 (0.00)**	0.10 (0.74)	0.14 (0.66)	-0.30 (0.17)	-0.12 (0.66)	**0.64 (0.01)**	0.14 (0.62)	0.04 (0.86)	-0.32 (0.26)
Mixed crops-livestock	-0.18 (0.41)	-0.21 (0.34)	-0.49 (0.14)	-0.15 (0.62)	-0.11 (0.74)	-0.28 (0.20)	-0.11 (0.69)	0.42 (0.13)	0.30 (0.27)	-0.11 (0.64)	-0.22 (0.39)
Specialist dairying	-0.01 (0.98)	-0.20 (0.38)	-0.35 (0.32)	-0.24 (0.43)	0.04 (0.90)	-0.11 (0.61)	0.05 (0.84)	**0.49 (0.05)**	0.37 (0.15)	-0.25 (0.29)	-0.26 (0.39)
Geo. Region (sandy)											
Kempen	0.05 (0.79)	**0.41 (0.05)**	-0.13 (0.64)	-0.16 (0.48)	-0.04 (0.89)	0.03 (0.88)	0.26 (0.24)	0.32 (0.22)	**0.52 (0.02)**	-0.30 (0.18)	-0.15 (0.54)
sand-loamy	-0.16 (0.44)	0.05 (0.84)	0.17 (0.57)	-0.21 (0.46)	-0.09 (0.79)	-0.25 (0.19)	-0.30 (0.23)	-0.03 (0.87)	0.19 (0.46)	-0.36 (0.08)	0.03 (0.91)
loamy	-0.01 (0.93)	0.04 (0.75)	-0.23 (0.20)	-0.09 (0.60)	-0.05 (0.79)	0.03 (0.83)	-0.03 (0.83)	-0.04 (0.81)	0.20 (0.26)	-0.28 (0.05)	0.04 (0.78)
meadow	-0.07 (0.52)	-0.08 (0.60)	-0.21 (0.23)	-0.10 (0.54)	0.01 (0.95)	0.01 (0.95)	-0.21 (0.13)	-0.15 (0.31)	0.20 (0.24)	-0.25 (0.08)	-0.15 (0.38)
Cons.	**5.43 (0.00)**	**3.99 (0.00)**	**3.05 (0.01)**	**2.67 (0.03)**	**2.53 (0.03)**	**2.74 (0.00)**	**2.33 (0.00)**	**3.30 (0.00)**	**4.69 (0.00)**	**2.24 (0.00)**	**5.18 (0.00)**

n = 364 ; p-value between brackets; bold = p<0.05

Risk attitude is significantly related to three of the reactive risk management strategies: keeping a buffer, avoiding loans and saving. Hence, farmers who are more risk averse are more inclined to use these reactive risk management strategies. However, risk attitude has a significant and positive effect on four of the seven proactive risk management strategies: product diversification, investing in technology, enlarging and income diversification. Farmers who are more willing to take risk are more prone to use these proactive risk management strategies.

The two socio-demographic variables age and level of education are mostly insignificant. Age is only significantly related to the intention to enlarge the farm (Table 4.5) and only in the SUEST model. Older farmers are less inclined to enlarge their farm, which is as expected, since after a certain age it does not pay off to invest in farm assets. However, no other significance of age on any other risk strategy was found. Velandia (2009) did find an important effect of age, but it could be that this is an indirect effect, since risk attitude was not taken into account. Level of education has only a significant effect on the intention to invest in technological optimization. Higher educated farmers are more inclined to invest in technological optimization on the farm compared to farmers with only elementary education. Having a specialization or major in agriculture during studies influence the decision to work harder. This could imply that farmers, who knew since a young age that they wanted to become farmers, are more ready to work hard on the farm. Farm type does not seem to be a very important predictor for the use of risk strategies, which is logic since these strategies are quite generic.

The percentage of subsidy received is not significant for any of the strategies with the exception for the use of contracts in the SUEST model. An effect could have been expected given crowding out effects. Indeed, it is generally assumed that single farm payments or decoupled income support schemes lead to a crowding out effect. This means that the subsidy that aims to stabilize income has a negative side effect of lowering the intentions of farmers to manage risk. However, subsidy has only a significant effect on the intended use of forward contracts, and in this case it is a positive effect. This effect is likely caused not directly but since farms that receive large amounts of subsidy typically have large amount of land and crops and therefore forward contracting becomes more impertinent.

Having a higher debt-to-asset ratio is significantly making the farmers more inclined to use forward contracts, this finding is similar to the literature we reviewed (Velandia et al., 2009; Knight et al., 1989). Both the mean and coefficient of variation and the standard output of the farm in our model is not significant. This result is unexpected and means that both the actual on-farm income and the volatility of that income are not important for the decision to implement risk strategies. The percentage of subsidy received is having a significant negative impact on the decision to diversify. Hence, farmers who receive more subsidies are less inclined to manage income risk by diversifying production. We mostly see no differences between the different farm types. The only significant differences are between specialist field crop farmers and cattle farmers for the decision to diversify production (cattle farmers, not surprisingly, are less inclined to do so) and between

arable farmers, specialist permanent crop and mixed crop farmers. Some significant effects of agricultural region are found, between sandy and sandy and loam areas for diversification and obtaining insurances.

4.5 Conclusions

We investigated a number of determinants of the intention to apply different risk strategies. Not a single determinant was significant over the whole range of different risk strategies. Therefore, the adoption of risk management strategies cannot be appointed to a single process. We found very little influence of different farm-characteristics on the choice of risk strategy. The socio-psychological variables seem to have at least as much, or even more impact. This indicates that the complex choice of risk strategies is mostly dependent on personality traits rather than external characteristics. Moreover, the total variance explained, represented by the adjusted R^2, is rather low for most of the strategies. Confronted with the same findings, Meuwissen et al. (1999) concluded that this could indicate that other variables that are more farmer specific are more important in determining the intended use of risk management strategies.

For most of the strategies, the typology of the farm is of no concern to the intended adoption of these strategies. Hence, the chosen risk strategies can be seen as generic, being useful regardless of the farm type. The amount of subsidy received as proportional to the NOI was not a significant determinant for any of the risk strategies with the exception of using contracts. This indicates that no evidence exists for a possible, and sometimes assumed, crowding out effect of subsidy payment. The past use of a particular risk strategy (whether or not with the intention to reduce risk) is nearly always positive related to the current intention to re-adopt the same strategy. Yet, the extent to which a farm was diversified did not show a significant relation to the intention to use diversification as a risk strategy. Also, we found that the intention to adopt one risk strategy was mostly positively correlated with the intention to use another risk strategy. Therefore, we adhere to the similar conclusion of Velandia et al. (2009), that this correlation should be taken into account in future research on intended use of farm risk strategies by considering this multivariate context.

The findings of this study could enhance the understanding of risk management and especially the significant findings could be taken into consideration for policymakers. Also the lack of proof for crowding out effects of income support scheme can be of relevance for policymakers.

Part II:

Contextualising risk

Chapter 5

Investigating risk perception closer to the actual understanding of risk by farmers

Based on: Van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., Wauters, E., 2013. Cognitive Mapping: A Method to Elucidate and Present Farmers' Risk Perception. Agricultural Systems, 122 (1): 42–52

Keywords: risk perception, cognitive mapping, grounded theory, farm-level risk management

Abstract: Assumptions on the perception of risk made in agricultural economic literature are recognized to be over-simplistic. For example, most studies assume that risks are independent and static, while in reality most risks are interlinked and dynamic. We propose an alternative method to identify and present risk perception, closer to the actual comprehension of risk by farmers. Grounded theory is used to investigate the perception of risk by farmers while avoiding to take prior assumptions. The main findings are: (i) farmers have difficulty to rank or score probability and impact of risks in a (semi)quantitative manner; (ii) farmers attach different meanings to risk when the focus shifts between uncertain event, probability, or value at stake, and; (iii) farmers perceive risks as being interrelated. Based on these findings, we propose that farmers risk perception can be best understood as a network of interrelated notions of uncertain events, their effects and uncertain outcomes. Furthermore, cognitive mapping is suggested to elucidate and present these networks. We test cognitive mapping, exploring dairy farmers' risk perception, and demonstrate the appropriateness of this methodology for capturing the complexity and context of perceived risk. Advantages are: (i) the qualitative approach, (ii) the focus on interrelations and context, (iii) the applicability at farm level, (iv) the farmer-driven rather than researcher-driven perspective, and (v) the elucidation of the polyvalent use of the risk concept. Cognitive maps can be used as a communication tool, a risk management tool, and a tool to stimulate bi-directional learning amongst farmers, policymakers, researchers and extension agents.

5.1 Introduction

Coping with the uncertainty inherent to farming is central to farm management (Hardaker et al., 2004). Farmers base their farm management on the information that they are aware of, thus their risk management is based on their risk perception. Indeed, different determinants are influencing risk behaviour indirectly via risk perception and risk propensity or risk attitude (Sitkin and Pablo, 1992).

In agricultural economic literature, decision making under uncertainty is typically studied with methods assuming rational approaches towards risk behaviour, in particular methods derived from the expected utility framework (Hardaker and Lien, 2010). In the context of agricultural economics, risk perception is mostly researched by methods that originate from the psychometric paradigm. In these models, risk is assumed to be: well-defined, independent, quantifiable and comparable. Although it is generally recognized that these assumptions are over-simplistic, they are commonly accepted as being 'realistic enough' (Hardaker et al., 2004). Despite a large body of literature discussing the appropriateness of expected utility (Shaw and Woodward, 2008; e.g.: Buschena, 2003; Rabin and Thaler, 2001; Starmer, 2000; Woodward, 1998; Harless and Camerer, 1994; Howard, 1992), it remains dominant in agricultural economic literature on farm risk.

These observations are described in more detail in a concise literature overview in section 5.2. Motivated by these observations, we aim at proposing an alternative method for presenting risk perception that is more in line with farmers' actual perception of risk. In our effort to avoid prior assumptions while investigating actual risk perception, we take a grounded theory approach. The suitability of grounded theory is motivated in section 5.3. Given the nature of grounded theory research, this study did not follow a conventional progression, instead different phases can be identified. In the first phase, we performed in-depth interviews with farmers in order to understand their perception of risk (see 5.4.1). In the second phase, risk perception was proposed as a network of perceived interrelated notions of risk (see 5.4.2). In phase 3, we explored the literature to select methods that can elucidate and present these risk networks (5.4.3). In the fourth research phase, we validated and illustrated the use of cognitive mapping for elucidating risk perception. For this purpose, we constructed and compared cognitive maps of five dairy farmers (see 5.4.4). The advantages, boundaries and limitations of cognitive mapping are discussed in section 5.4.5 and in section 5.5 we conclude.

5.2 Observations from agricultural economic literature on risk behaviour and risk perceptions

Formal methods to describe and analyse risk in agriculture have received increasing attention in the last decades (Hardaker et al., 2004). In agricultural economics, decision making under uncertainty has been typically studied using logical choice models (Thompson, 2009). These rational approaches assume

maximization of profit or utility as major drivers for decision-making. One rational approach in particular, expected utility, has been almost universally adopted in the economic literature (Hardaker and Lien, 2010).

Observation 1: In agricultural economic literature, decision-making under uncertainty is typically studied with methods taking rational approaches towards risk behaviour, especially methods derived from the expected utility framework.

In an expected utility framework, decision-making under uncertainty is explained given the value of an outcome in function of a state of the world and the probability of this state. Probability is either assessed with frequency data or by elucidating subjective probability, i.e. stated expected chances that risky events occur. In order to avoid expected utility models to be used solely for decision problems for which frequency data is available, Hardaker and Lien (2010) propose that more research effort should go into investigating methods to elucidate subjective probabilities.

In the field of agricultural economics, most research on elucidating farmers' risk perception is performed within the psychometric paradigm. This approach is rooted in psychology and decision theory (Rippl, 2002). Perceived risk is typically measured by listing risky events or activities and scoring them, using quantitative or mixed (qualitative and quantitative) approaches. These studies have led to various valuable insights on farmers' risk perception. For instance, research within this paradigm has exposed characteristics of risk that strengthen and others that weaken risk perception (Sjöberg et al., 2004).

In the agricultural context, methods based on the psychometric paradigm have been used to identify perceived sources of risk and their relative importance. In risk mapping, for instance, the perceived probability of being confronted with a particular risk is positioned against the impact of that same risk (Hoag, 2009). In this way, the combined probability and impact of several risks can be visually compared in a two dimensional matrix. Risk maps are conventionally constructed using interviews. The interviewee is first asked to list and then to score all the risks (s)he perceives (Quinn et al., 2003; Smith et al., 2000). Risk mapping offers an approach to elaborate on the biggest worries of farmers. In a policymaking context, such normative approaches can offer advice for measures to be implemented.

In risk mapping, several assumptions are made about risks. Implicit in this method is that risk is understood consistently by different farmers, i.e. a well-defined concept of risk is assumed. While listing risks, it is assumed that different risks can be independently assessed. Scoring probability and impact of risks assumes risk events to be discrete phenomena that can be quantified as such. Furthermore, it is assumed that scores can be compared, assuming a single scale. Finally it is assumed that assessment of probability and impact scores can serve as a proxy for the magnitude of the perceived risk.

Observation 2: Risks are assumed to be well-defined, independent, quantifiable and comparable.

Whereas these assumptions hold for some theoretical elaborations about risk and uncertainty, actual risk perceptions have been shown to differ significantly from what is prescribed by classical decision theory (e.g. March and Shapira, 1987). Rational approaches adopting these assumptions do not always offer good predictions for decision making in real life. This point is well-expressed by Wilson et al. (1993, p.89): "*These rationality based paradigms have produced a rich and useful body of theory, yet their ability to describe actual decision-making processes has not always matched the mathematical elegance of their derived rules*". It is generally accepted that human (risk) behaviour is too complex to be explained by any model and expected utility is considered to be at best "good enough" (Hardaker and Lien, 2010). Moreover, the assumptions on which these rational approaches are based are debatable and decision makers do not often take such rational decisions (Renn, 2008).

Observation 3: The assumptions about risk made by the rational approaches on decision- making are known to be simplistic and not always realistic.

The postulation that the understanding of risk held by managers and decision makers is well reflected by such models is crucial to these studies of risk behaviour. Hence, the assumptions are accepted given that the representation of 'risk' is "sufficiently like the real situation" (Hardaker et al., 2004, p.20), despite the reduced complexity of the risks under analysis.

Observation 4: The assumptions on risk, even though known to be unrealistic, are widely accepted in agricultural economic literature as they are necessary for the universally used decision models.

We do not wish to participate in the extensive body of literature debating on whether expected utility theories are useful and under what circumstances (Shaw and Woodward, 2008; e.g.: Buschena, 2003; Rabin and Thaler, 2001; Starmer, 2000; Woodward, 1998; Harless and Camerer, 1994; Howard, 1992). In this study we do not argue in favour or against expected utility. Rather, we are motivated by the general acceptance of the simplistic assumptions on risk in agricultural economic literature, to investigate actual risk perception.

5.3 Data and methods

5.3.1 Study area and participants

For this study, we interviewed 19 farmers, living and working in the two Belgian provinces: Flemish Brabant and East Flanders. The farmers were selected according to purposeful sampling (Coyne, 1997). The first farmers were randomly selected from a public list. Additional farmers were found by asking the interviewed farmers whether they knew other farmers who would possibly be interested in participating in this study (snowball effect). During the first phase of the study, 14 farmers were interviewed: 6 dairy farmers, 1 mixed dairy and meat farmer, 2 crop farmers, 1 mixed crop and pig farmer, 2 flower growers, 1 fruit grower, and 1 sheep farmer. In

the last phase of this study 5 additional dairy farmers were interviewed. The farmers aged between 35 – 65 years and 16 male and 3 female farmers participated. For most farmers, farming was their primary source of income, however, 11 of the 19 farmers had an additional income on or off the farm.

5.3.2 Grounded theory

In the field of agricultural economics the conventional approach to research is quantitative, i.e. theory is derived and confirmed using calculable data. Agricultural economics as a field has been less open to qualitative research (Georgakopoulos, 2008; Bitsch, 2005). It is in this quantitative tradition that most of the approaches to elucidate risk perception in an agricultural context are rooted. However, quantitative approaches alone do not suffice to elucidate complex issues such as risk perception, or according to Renn (2008, p.99): "*Technical and solely quantitative approaches for characterizing risks are obviously inadequate to reflect the complex pattern of individual risk perception*".

We used an established qualitative methodology from the social sciences, the grounded theory approach, to gain an understanding of farmers' perception of risk. This approach is particularly suited for our study, since it is an approach that focuses on the social psychology of the actors studied (Georgakopoulos, 2008; Glaser and Strauss, 1967). Within the grounded theory approach, the focus is on collecting and analysing data to identify concepts, ideas, views and parameters and assess the interpretation of the actor's problem and the way he or she solves this problem (Georgakopoulos, 2008). Grounded theory is generated through the abstraction of concepts and their relations coded from qualitative data (e.g. interview transcripts). Validation is performed by comparing, in a cyclical process, the deduced concepts and their relations, the theoretical explanations and hypotheses, to the newly acquired data (Strauss and Corbin, 1998). This cyclical process, typical for the grounded theory approach, not only advances the selection of new data sources, a process known as selective sampling, but also ensures proper validation (Strauss and Corbin, 1998).

This study used the typical cyclical process and was divided into four phases (Figure 5.1). The first phase was the initial investigation of risk perception and was based on the first fourteen interviews. The second phase consisted of the analyses of the observations made from the interviews. In this second phase, the network structure of risk perception emerged. The third phase consisted of a literature review to frame the emerging theory in existing theory and literature, and also served as a triangulation for the findings from the interviews. Cognitive mapping was found to be a suitable method to elucidate and present farmers' risk perception. In the fourth phase cognitive mapping was tested as an approach to understand the risk perception of five additional dairy farmers. Whereas the four phases are clearly distinguishable, the whole procedure, in particular up to phase 3, followed a rather iterative approach. As such, the findings from the interviews were confronted with the findings from the literature, after which the focus and targets of the next interviews were slightly adapted.

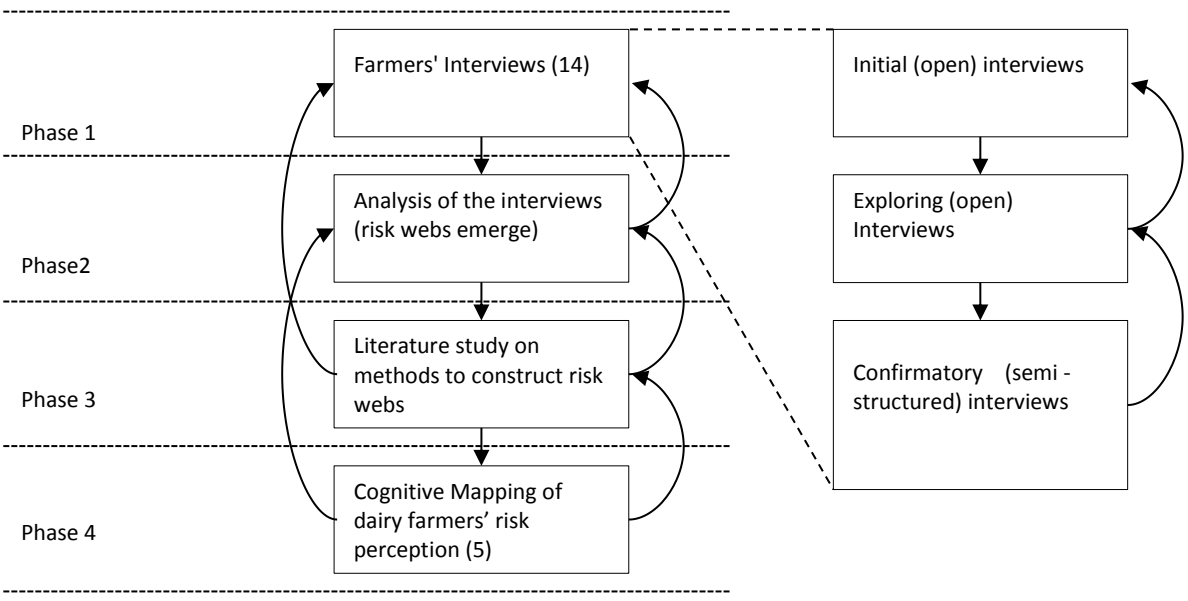

Figure 5.1: The cyclical research design typical for grounded theory that was followed in this study. In phase 1 and 4, the numbers in between brackets indicate the number of farmers interviewed for this phase.

For the interviews of phase 1 and 4, participants were first contacted by phone and shortly briefed about the aim and the scope of the study. In phase 4, we explained that cognitive maps would be constructed from the interviews. On average, an interview took 1.5 hours and all interviews took place at the farmer's home. One interviewer performed all interviews. The interviews were non-directive and had an open character. During the interviews, it was aimed to understand why the mentioned risk was perceived as such and why it was a worry for their farm and household. All participants were first asked to briefly describe their farms, then to give a short history of changes and finally to speak about their difficulties on the farm and their worries about the future. The words "difficulties" and "worries", were used rather than "risk", in order to avoid influencing the interviewee about the framing of "risk". When the interviewee used the concept "risk" in his or her answer, the interviewee was encouraged to speak more about the subject. Questions were mainly open-ended and follow-up questions were used to gain more clarity and details. For explorative purposes, some of the farmers were asked to list risks, or score probability and impact of the mentioned risks, such as is done in classical risk mapping.

The interviews were transcribed and coded in QSR's NVivo 9. To reduce the number of initial codes, qualitative aggregation was used, combining different similar codes into one larger code (Özesmi and Özesmi, 2004). Concepts and relationships were derived from the transcripts of the interviews through qualitative interpretation of the researchers. Given that the objective of this study was to explore the risk perception of the farmers, a confirmatory approach towards the clarification of the concepts and relationships was taken, i.e. no list of possible concepts or nodes was prepared in advance. During the process of coding and interpreting the data, the results were frequently discussed between the co-authors. The literature study in the second phase served as an additional form of triangulation. The interviews were

conducted in Dutch; the quotes and cognitive maps that are published in this Chapter are idiomatic translations.

5.3.3 Cognitive mapping

As a result from the first three phases of the grounded theory approach, cognitive mapping has been chosen as a method for elucidating and presenting risk perceptions. No convention exists for constructing cognitive maps (Wood et al., 2012). Indeed, the method of getting fragmented information out of people's heads and onto paper in a constructive manner is not straightforward (Howard, 1989). Furthermore, methodological concerns have received relatively little attention; scientific research has focussed more on the conceptual and practical application of cognitive maps (Carley and Palmquist, 1992). However, Carley and Palmquist (1992) propose a method for mapping mental models.

It is possible to construct cognitive maps from questionnaires, written texts or by inferring them from observed action (Özesmi and Özesmi, 2004). In the last phase of this study, five maps were constructed by the researchers using the recordings of the interviews.

All concepts stated in the interview were coded. A concept refers to a transcribed word or group of words relating to one specific idea. The codes were classified into four aggregated categories: "causes", "effects", "values at stake" and "risk management", that emerged during the interviews (see 5.4.1 for clarification about these categories). "Causes" translate, in the cognitive map, into uncertainty nodes and represent the concepts that contain the source of uncertainty, e.g. bad weather, volatile prices or diseases. "Effects" translate into effect nodes and represent mentioned consequences of uncertain events and previous effects, e.g. bad yields, less turnover or decreasing income. Value nodes represent those consequences that really mattered to the farmer, that is the "values at stake", e.g. making sufficient profit, good health, high quality of life or pride. Examples of "risk management" nodes are using future markets and engaging in contracts.

After that the concepts were coded into nodes representing the four emerging groups, these individual nodes were linked, representing revealed relations between the concepts. For example, bad weather was linked to decreased yield if the farmer mentioned how bad weather could lead to decreased yields. The sign of the relationship can be positive or negative, which is determined by the framing of the related concepts. For example, a concept can be framed as "output price" and be positively related with "net income"; however, if the concept is framed as "decreasing output price" it would be negatively related with "net income". Bi-directional relations (stress leading to less pleasure in farming leading to more stress) and loops (an investment can lead to growth which can lead to higher net income which can lead to another investment) are allowed in the diagram. The strength of the relationships is not incorporated in the map, simply because they were typically not revealed by the farmers (see 5.4.1 for an explanation about the difficulties regarding the quantification of risks).

After their completion, the cognitive maps were sent to the farmers with the request to revise them if needed. The Banxia software package "Decision Explorer" was used to perform the analysis of the cognitive maps.

5.4 Results and discussion

This section is divided into five subsections, of which the first four can be linked to the four research phases. The first subsection explains the findings from the first fourteen interviews. In the second subsection, we describe how the perception of risk emerged as a network of interrelated concepts regarding uncertain events, effects and values at stake. The third subsection summarizes the literature review of the mapping methods that we performed and concludes that cognitive mapping is a suitable method for elucidating the farmers' networks of risk perception. The fourth subsection illustrates the use of the cognitive maps for understanding risk perception among five dairy farmers. The fifth and last subsection provides a critical reflection on the use of cognitive mapping for elucidating farmers risk perception.

5.4.1 Observations on risk perception

From the first fourteen interviews we derived three key insights: (i) quantification of both probability of occurrence and impact is problematic; (ii) the focus on risk is not coherent; (iii) all risks and steps in the risk chain are interlinked, which makes it very difficult to separate them.

Quantification of risk is problematic

Farmers find it difficult to list risk events and score their probability and impact, as it is performed in elucidating subjective probabilities or in risk mapping. Listing risks was possible to a certain extent but problematic nonetheless. One farmer made the problems connected to this task very implicit. When asked to come up with additional risks, not yet mentioned in the interview, he replied:

"*There are too many risks; if you want you can make a risk out of everything*" (F.09.1)

After being asked to score the risks that had emerged during the interview and that we had listed, his answer was:

"*I do not want to do that, that is beyond reason.*" (F.09.2)

Another farmer, when asked to rank price risk in comparison with other risks, replied:

"*It is impossible to compare that. You do not have any control over any of them*" (F.07.1)

And yet another farmer confirmed the reluctance towards separately listing different sources of risk:

"*We won't think about all possible risks. Neither will we make a list of the largest risks. It is probably better that we don't. If we had to think too much about all the risks we are faced with, we wouldn't dare to be independent farmers. There are so many things that can possibly be dangerous for the business. We do keep that in mind, but we cannot think too much about it or we wouldn't have dared to do what we have done up to now.*" (F.12.1)

The conventional methods assessing farmers' risk perception assume farmers to take a categorical and quantitative position regarding perceived risk. In surveys or interviews, the farmer is required to contemplate on risk in a restricted but analytical convenient way. However, as we demonstrated, thinking about risk in this manner, comes unnatural to the farmers. We noticed that any quantitative approach to mapping the perceived risks was problematic. Furthermore, generalization and categorization of risks seemed unnatural to the interviewed farmers.

<u>The focus on risk is not coherent</u>
Different farmers use the concept of risk differently. Moreover, even the same farmer attaches different meanings to the concept of risk while describing different risky situations and even when describing one and the same risky event. The interviews show that the farmers relate risk either to uncertain events, the probability of this event, or the values at stake. Their focus, however, was only on one of these three aspects at one time.

Sometimes risk is used to describe an uncertain event:

"…according to me fuel prices are a risk." (F.13.1)

"Every dairy farm, every meat farm can get a disease - that is a risk. Weather conditions are also a risk." (F.10.1)

In other cases, the word risk is used to describe the possibility or probability of some event happening causing personal goals to be at stake, i.e. a possibility that something goes wrong:

"Still the risk is always present even if you cannot define it. Sometimes you are at risk. For example, when you use a grinder, even if you wear safety boots, there is always a risk." (F.10.2)

"The risk of a health issue occurring that affects the manager is probably smaller than the risk that there is some market failure. I mean, during your career the risk that you would face a market risk during an x number of years is much bigger than the risk that there will be long-lasting health issues with the farm manager." (F.12.2)

Finally, the word risk is sometimes used to describe the negative impact of an uncertain event:

"That is perhaps the risk: family life…" (F.08.1)

"We are using machines: those people are working with them. There is always a probability of something happening. A girl puts her fingers between the boxes and crushes her fingers. Those things happen, and we are insured against those things, but it is a risk". *(F.08.2)*

Although the focus in these examples is either on the cause, the probability or the impact, the three factors are implicitly regarded. The perceived source of uncertainty gives rise to a perceived value to be at stake. It is the event that happens with some probability or uncertainty, but it is the impact that makes it a risk. Mostly there is not a direct link but there are several steps in between. For example, the weather conditions (the source of uncertainty) mentioned in the second quote, are only a risk because bad weather can lead to bad yield and hence bad income (impact). Hence, the chain of risk events, leading from an uncertain event to the value at stake, is only implicitly regarded while the focus is on a particular link in the chain.

This result is in agreement with findings in the literature on similar polyvalent use of the definition of risk (Bouleau, 2011; Aven, 2010a; Ben-Ari and Or-Chen, 2009; Bammer and Smithson, 2008; Kunkel, 1998; Kaplan, 1997; Thompson and Dean, 1996). No consensus can be found in scientific literature about the notion of risk. Concepts of risk differ between and within different scientific fields. In most literature, risk is approximately defined as an uncertain event causing a loss of something of value (Aven, 2010b, 2011), and is often expressed using the following formula:

$$\text{Risk} = \text{Event} \times \text{Probability} \times \text{Loss} \qquad [6.1]$$

Although often all of the components are considered, the focus usually differs and is on either the uncertain event, the probability, the value at stake, or two or more of these combined.

Perceived interconnectedness of risks

A third observation from the interviews concerns the interdependence of the perceived risks. The interviews revealed that different, seemingly separate risks, are interconnected.

The next two quotes refer to farmers linking two different and separately perceived risks, or more precisely two values at stake, namely the health of the farmer and income:

"…if you are not able to work anymore because of ill health, you will end up with a financial problem as well. If you can't work, you can't get your product sold." (F.07.2)

"… and your health… If you cannot work, there will be a serious risk for your income" (F.08.3)

The next quote illustrates how an attempt to decrease risk can result in an even riskier situation. A farmer speaks about a cause of risk (volatile prices) and a way to manage this uncertainty (using futures), however, the future contract in itself is a cause of risk when the farmer produces too little to deliver according to his contract:

" … by taking a position on the future markets. That doesn't mean that you are completely free of risk. It can actually be that it puts you in a risky situation. Contract production in the potato industry for example… You signed a contract and you have to deliver. If you cannot harvest, your fate is in the hand of the other party that signed the contract. He could demand that you have to deliver the agreed amount of kilos or pay a fine. You are actually taking a much larger risk, in this case, than you set out to prevent. This is the exception that proves the rule, but it does happen." (F.12.3*)*

In short, many different factors play a role in the risk faced by a farmer and often the perspective gets lost: many sources of uncertainty lead to the same value being at stake:

"…to say it is this, or that… no it is the market, it is the climate it is… Nowadays it is the speculation on food products. It is the whole package." (F.03.1)

"However, if the weather is fine then the sales continue, there is less supply and the prices are correct. There are so many factors playing a role. Everybody is looking for things. Only on hindsight you can say what factors were significant. There is no way of knowing." (F.13.2)

"The quota might have disappeared but there will be something else, maybe licenses or something like that." (F.03.2)

"We just are dependent on too many factors; it influences our family life." (F.08.4)

The interdependence of risks is pertinent at farm level. Interrelations occur at the level of uncertain events, the effects thereof and at the outcome level. These interrelated steps are the cause of the complexity of perceived risk. It is this complexity that makes it so difficult to precise risk.

5.4.2 Farmer's risk perception as network of interrelated notions of risk

From the interviews it became evident that risks cannot easily be quantified or listed. Besides, it appeared that the concept of risk is not consistently used and that different risks are interlinked. An alternative method elucidating and presenting risk perception should explain these observations.

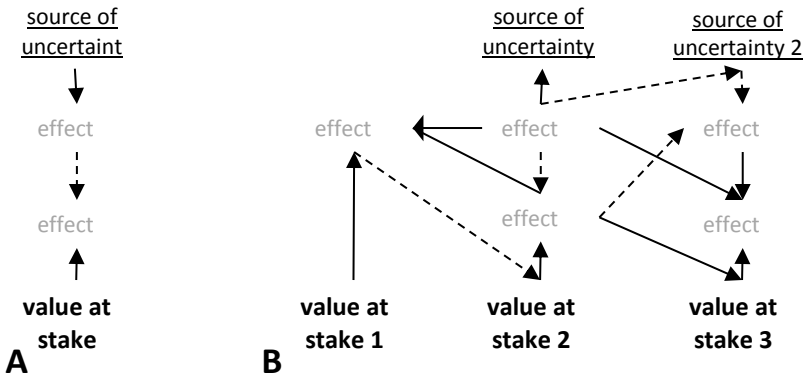

Figure 5.2: An example of a simple cause-effect chain (A) and a web of interrelated sources of uncertainty, effects and values at stake (B)

In most cases, it is unnatural for the farmers to score risks regarding probability and impact. The reasons why it is hard to elicit these scores are fourfold. First, in many studies it has been shown that a layperson has many difficulties to assess probability in general (Weinstein, 1999). Second, the probability of an uncertain event happening corresponding to a given impact is usually not discrete but follows a probability distribution, which makes it even harder to assess. Third, probability and impact scores are context-specific, making it impossible to score risk out of context. Fourth, the relations between different uncertain events, other events and different values at stake are interrelated and complex.

Farmers, without a coherent concept of risk in mind, switch from using the concept as a synonym for probability, an uncertain event, and a value at stake. Essentially, when speaking about a risk, farmers are focussing on a part of this "network" of interrelated events, effects and outcomes. For example when speaking about climate as a risk, the farmer focuses on the source of uncertainty, being climate, and only implicitly considers the relations between climate factors and possible consequences of bad and good climatic conditions. The entire "network" of interrelated aspects of risks is too extensive to allow taking everything into account at once. In order to distinguish and categorize risk in the network of interlinked and interdependent factors, the focus is on one aspect of risk at a time.

Risks are not perceived in isolation; rather they are embedded in their context and are inherently linked with other risks. Hence, risk is not perceived as a single chain of an uncertain event leading to an uncertain outcome (Figure 5.2A), such as in classic representations of risks. Instead, the context and interrelations of risks appear central and suggest a network of perceived interrelated causes of uncertainty, effects and outcomes (Figure 5.2B). Different events, each more or less (un)certain, cause different chains of effects to interact with each other and result in one or more values being at stake.

5.4.3 Risk networks in literature

The idea that different risks in agriculture are interlinked to form a network, web, or constellation of risks is not new. The OECD (2009) recognizes the importance of inter-linkages in agricultural risk management at the policy level. The Risk

Response Network of the World Economic Forum uses a risk constellation approach and focuses on the risk network rather than on a single existential risk (World Economic Forum, 2012). The focus in this report is on the interconnectedness and interplay between different global risks. Literature about the interrelatedness of risk at the individual or farm level is much scarcer. Jurt (2009) uses an approach of interrelated risk on the level of perception. She uses idealized risk webs as a basis for a typology of actors in a rural area in the Tyrolean Alps. Personal construct theory, developed by Kelly (1963), offers a more general approach for investigating individual behaviour (not necessarily focusing on risk perception). In personal construct theory, mind maps are used in order to understand individual reasoning (Thompson, 2009). Hardaker and Lien (2010) suggest that mind maps or influence diagrams can help elucidating subjective probability. In the domain of decision analysis, maps of mental models have been constructed for elucidating the process of making decision under uncertain conditions.

Maps of mental models offer good representations of risk networks, since they also reflect networks of interrelated concepts, or in the words of Carley and Palmquist (1992, p.608): "*A map is a network formed from statements. By sharing concepts, statements can form networks. […] The resultant network, or map, is a representation of a mental model*". Carley and Palmquist (1992) explain concepts and their relations in the context of mapping mental models as follows: Concepts refer to a single idea or "an ideational kernel", the meaning of which is dependent on the relation with other concepts. A relationship is the connection between two concepts. It has four aspects, namely (i) meaning: a relationship itself can also exist of a concept or idea stating something about the bond between two different ideas; (ii) direction: a relationship is bidirectional when the two connected concepts are equally dependent on each other (e.g. grain price and grain yield), or unidirectional when one concept is leading and the other following (e.g. severe drought can lead to yield loss); (iii) sign: a relationship can be positive or negative; and (iv) strength: the strength of a relationship depicts the intensity of the impact that two related concepts have on each other. The strength can also be discarded in a pure qualitative description of concepts and relations, as in the case of risk networks.

Methods for mapping mental models originate from different fields and for slightly different purposes. Some methods have a focus on one main concept, such as mind mapping or dialog mapping (Brightman, 2003), while others do not assume one central concept, like cognitive mapping (Wood et al., 2012), concept mapping (Brightman, 2003) and causal mapping (Montibeller and Belton, 2006). Some have a hierarchical structure, e.g. influence diagramming (Carriger and Newman, 2011; Bostrom et al., 1992) and concept mapping, while dialog mapping (Brightman, 2003) does not have a hierarchical structure. Some focus on the complex relation between concepts, e.g. concept mapping (Brightman, 2003), while others take a causal relation between concepts, e.g. causal mapping (Montibeller and Belton, 2006) or cognitive mapping (Zhu and Timmermans, 2010). Some allow bi-directional relations and feed-back loops, i.e. links from concept to concept forming a circular pattern, e.g. cognitive mapping, and some do not, e.g. influence diagrams (Howard and Matheson, 2005). Most of these methods are qualitative by nature but

strength can optionally be appointed to their depicted relationships (often the method is then called fuzzy, like fuzzy influence diagrams or fuzzy cognitive maps). Partial overviews of these mapping methods are presented under different aggregate names, for example: mapping methods for qualitative data structuring (Brightman, 2003), knowledge maps (Howard, 1989), or visualization formats (Eppler, 2006).

Based on a review of the available methods for constructing the risk networks, we opted to use cognitive mapping. Cognitive mapping finds its roots in personal construct theory (Eden, 2004) and was first coined by Tolman (1948). A cognitive map is a diagram of concepts and their relations about a specific issue (Brightman, 2003). The relations can be regarded as causal, either positive or negative, and can be read as “may lead to” or “might jeopardize”. An example of the use of cognitive mapping in agricultural context is given by Isaac et al. (2009) assessing local knowledge in agroforestry management.

Cognitive mapping, as a method to elucidate networks of perceived risk, fits with the findings from the interviews. First, cognitive mapping allows for a qualitative approach. Second, the nodes in cognitive maps can be classified in groups, and the relations between the nodes reflect causality, corresponding to perceived sources of uncertainty, effects and values at stake and their causal links. Third, each node may be connected to any other node; hence, the map is a representation of a network analogous to the perceived risk networks. Furthermore, out of the different mental mapping methods, cognitive maps best fit with the risk networks, based on the different aspects illustrated above, e.g. assumed causal relations and inclusion of bi-directional relations and feed-back loops.

Özesmi and Özesmi (2004) noted that cognitive maps can be particularly useful in five situations: (i) when dealing with complex problems; (ii) in situations where human behaviour is important but hard to quantify; (iii) in situations where personal knowledge is available while scientific knowledge is incomplete; (iv) in situations where problems are wicked, involving many parties and without easy solutions; and (v) in the case of desired public involvement. All circumstances described above are applicable to the case of farm risk management. Indeed, risk management is hard to quantify, farm risk management is based on farmer’s knowledge, farmers have to cope with many parties for buying and selling input and output and farm risk management is constrained by rules and agreements reflecting public opinion.

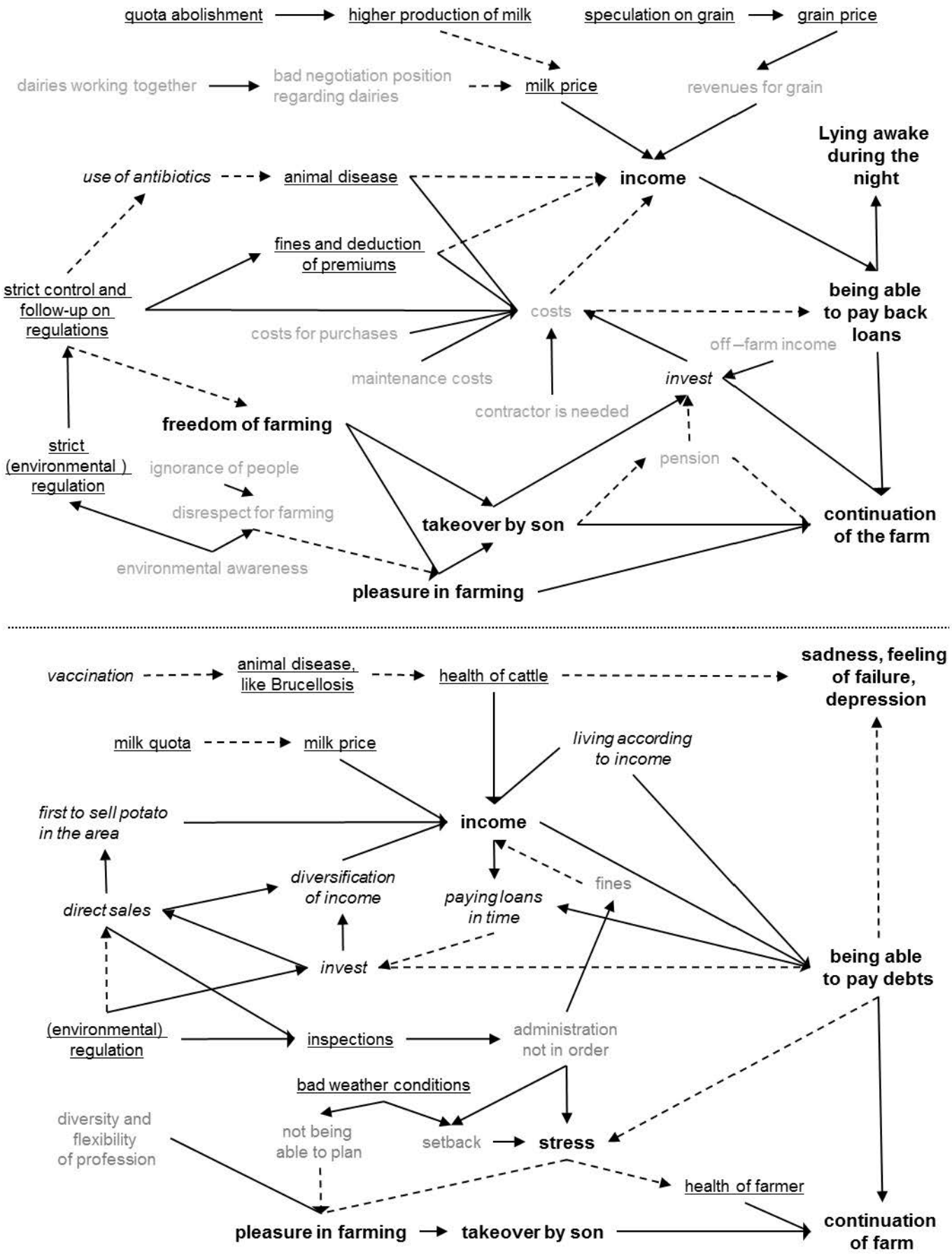

Figure 5.3: Two examples of cognitive maps of dairy farmers. Source of risk nodes = underlined; effect nodes = grey, risk management nodes = italic and value nodes = bold

5.4.4 Use of cognitive mapping to elucidate risk perceptions of dairy farmers

In the last phase of this study, we constructed and analysed individual cognitive maps for five dairy farmers in order to test the suitability of this approach for elucidating farmers' risk perception. Examples of two cognitive maps are given in Figure 5.3. Overall, 77 different concepts relating to perceived farm risks were recognized. The overlap, or similarity, between the different maps is remarkably high; 44% of the concepts were mentioned by at least two farmers (
Table 5.1). The concepts that were mentioned only once (56%) were mostly specific to the farm, such as "direct sales of potatoes and ice cream"; very particular ideas on what contributes to the uncertainty of some other concepts, such as "growing world population"; or a specific value at stake: "lying awake at night". The concepts that were mentioned at least by three out of the five farmers are given in Table 5.2.

All five dairy farmers thought of income as a very important aspect in their understanding of risk. In three out of five maps, "income" is the most central variable and in two out of five maps, "income" is the domain variable with the most connections (Table 5.3). Centrality analysis and domain analysis both look at how prominent a variable is within a cognitive map. Domain analysis looks at the direct incoming and outgoing arrows or relations from each variable and centrality analysis also takes indirect relations into account, adjusting scoring for the relations further away. This signifies the importance of income as a measure for all kind of risks. Even farmers' health was often not seen as a value at stake but as a source of uncertainty linked to income; they stated that there would be loss of income when a farmer would cease to work because of illness. The most mentioned values at stake were "continuation of the farm", mentioned by all five farmers, and "pleasure in farming", mentioned by four farmers. The most mentioned sources of uncertainty, mentioned by all five farmers, were "animal disease", "milk prices" and "regulations" (Table 5.2). "Savings", interestingly enough, is only mentioned by one farmer as a risk management option.

The total numbers of nodes or concepts in the cognitive maps of the five farmers are given in Table 5.3. The number of concepts in the maps varies between 25 and 37, implying relatively similar complexity in all five cases. More concepts in the map suggest dense information and a multifaceted comprehension of the reality; or in the words of Eden (2004, p.676): "*The more nodes in the map, the more complex is the map and hence the more complex is the issue*".

Table 5.1: The cognitive maps of the five farmers show a substantial overlap in the mentioned concepts

# of different farmers mentioning the concept	# of concepts	% of concepts
1	41	53%
2	14	18%
3	11	14%
4	6	8%
5 (all)	5	7%

n = 5

Table 5.2: The concepts that were most mentioned in the constructed cognitive maps of the five dairy farmers

Concept	# of different farmers mentioning the concept
animal disease	5
continuation of farm	5
income	5
milk price	5
regulation	5
controls	4
fines	4
health cattle	4
invest	4
pleasure in farming	4
weather conditions	4
available arable land	3
being able to pay debts	3
costs	3
dairies cooperation	3
grain price	3
health of the farmer	3
milk production in Belgium	3
milk quota	3
price arable land	3
production	3
revenues	3

n = 5

Table 5.3: Some characteristics of the five constructed cognitive maps

case	# of concepts	# of links	L:R ratio	map density	domain variable	centrality variable
1	33	44	1,33	0,67	increasing costs	increasing costs
2	35	52	1,49	0,74	income	being able to pay debts
3	25	29	1,16	0,58	income	income
4	27	39	1,44	0,72	regulations	income
5	37	52	1,41	0,70	knowledge / health cattle	income

n = 5

All maps have a high number of head and tails, i.e. nodes without outgoing arrows and incoming arrows, respectively. This high number of both heads and tails refers to a relatively flat structure of the cognitive map and indicates a rather complex problem (Eden, 2004). It also means that the farmer does not have a single goal in mind when thinking about farm risks, nor does he sees one central cause of risk. This is also reflected in the total number of sources of uncertainty and the number of values at stake that were mentioned (Table 5.4). The number of sources of uncertainty mentioned made out more than one-quarter of all concepts mentioned, hinting at a large number of inputs for risk.

The relatively similar map density among the maps of the five farmers indicates comparable complexity regarding risk perception (Isaac et al., 2009). Map density is calculated as the number of links divided by twice the number of concepts. Another characteristic of cognitive maps is the ratio of links to concepts. This ratio should be low, ideally around 1.2, although there is no consensus about this (Georgiou, 2009). In general it is assumed that a high ratio is caused by inexperience of the interviewer. The average ratio in this study was around 1.4, which is acceptably low.

Table 5.4: Percentage of types of concepts mentioned

Type of concept	# of concepts	% of concepts
source of uncertainty	43	28%
effect	68	44%
(risk) management	20	13%
value at stake	22	14%

n = 5

5.4.5 Critical reflections on cognitive mapping to elucidate farmers risk perception

Advantages of using cognitive mapping

A first advantage of cognitive mapping is its qualitative nature. This solves one of the greatest difficulties in conventional risk perception elucidation methods, where quantitative (scoring) or semi-quantitative (ranking) expression of probability and impact is expected from the respondents. Cognitive mapping circumvents this problem, while still providing a detailed and comprehensive overview of risk perception.

Second, while their interconnectedness impedes the separation of different risks, the objective of cognitive mapping is precisely to elucidate the context and reveal the complex interrelations between diverse risk events. A detailed overview of many complex aspects of the farmer's perceived risk can be constructed using cognitive mapping, or in the words of van Kouwen et al. (2009, p.65): "*Cognitive maps allow for the representation of complex systems, as well as their relationships in a comprehensible diagram*". According to Niemeijer and Groot (2006), the approach of considering causal networks rather than causal chains is more effectively dealing with the complexities of the real world.

Third, cognitive maps are applicable at the farm level and are farmer-driven. The risks considered in this study are pertinent at farm level. More specifically, they concern the perceived risk by the farmer. The cognitive map offers a simple and intuitive approach for farmers to assess the individual risk they face, or rather the risk they perceive to face. Furthermore, cognitive mapping allow the farmers themselves to identify important and unimportant variables. In that sense, cognitive mapping is largely farmer-driven, whereas conventional methods frequently employed in agricultural research, such as survey and questionnaires are, to a large extent, researcher-driven. In this study, we opted to construct the cognitive maps based on the interview transcripts of the farmers. In future research farmers

themselves can construct their own cognitive maps of risk perception. Although in our experience these maps were less elaborated, research has indicated that farmers are able to construct causal maps of their farming systems (Fairweather and Hunt, 2009).

Boundaries in cognitive maps

A cognitive map is not only providing information about the declared concepts and their relations. Equally important information can be derived from risks not revealed by the farmer. A cognitive map can never be complete. Indeed, the possibility remains to add concepts to the map and further deepen the relationships. However, the map needs boundaries to prevent it from becoming incomprehensible. Choosing these boundaries is at the discretion of the builder of the map. It is important to acknowledge this and be aware of the reasons of the choices of the map boundaries.

First and foremost, boundaries are based on what is considered as a risk by the farmer and what is not. Risk is a subject open to interpretation; and as a result the content of a cognitive map is the interpretation of risk by the farmer. For example, from the interviews it appeared that many farmers do not consider small manageable volatilities (like minor infections of fruit trees) as risks. For these farmers, risk involves the events and values at stake that have a huge impact and that they cannot control themselves. These interpretations determine what content will be considered in the cognitive map or not, or in other words, what constitutes the boundaries of the map. Hence, part of the incompleteness of a cognitive map exists only in the researcher's mind. Farmers do not regard several aspects that are considered risks by the research community; instead, they view these "risks" as certain variability.

Second, the farmer will probably forget to think about some facets of the risks his farm is facing, although he can readily recite these at other times. The cognitive map is a dynamic map that changes over time, i.e. the aspects and relations in the map will change in another situational context on the farm and changes with the farmers' knowledge on the subject.

Third, the farmer might not be aware of all risks he faces. These unknown aspects to farmers can be known by other farmers, researchers or extension agents (*known unknowns*); others are simply unpredictable and unknown to everyone (*unknown unknowns*).

Possible uses for cognitive mapping

Human beings are only capable of taking a limited number of information chunks into account at a time (Shiffrin and Nosofsky, 1994; e.g. Miller, 1956). Given the complexity, due to the large number of factors involved and their interrelations, the farmer is restrained in perceiving the comprehensive and detailed overview of all risks he faces and the relations between them. Cognitive mapping provides a tool to compose a comprehensive overview from the fragmented information in the farmer's mind. By providing this overview of the broad mental model of risk perception,

cognitive maps can help to focus on one part while not losing track of the context and the bigger picture. This overview can be used for several purposes.

First, cognitive maps provide a useful method for facilitating the understanding and communication about complex problems (Wood et al., 2012). Farmers do no use the concept of risk consistently; rather they switch from using the concept as a synonym for probability, an uncertain event, and a value at stake. This partial focus is due to the fact that the entire network of risk is too comprehensive to be considered at once. Using cognitive maps allows maintaining the comprehensive overview of perceived risk and while still providing details. Hence, cognitive maps allow for meaningful and intuitive communication about risk on the farm.

Second, the cognitive map could be employed as an additional aid for risk management. The focus of the method on the context make cognitive mapping a key tool for decision analysis (Howard and Matheson, 2005). Most tools for aiding risk management aim to control or diminish a specific source of uncertainty, e.g. future contracts for insuring against volatile prices or different insurance policies for yield. Different risks are necessarily treated separately as a single chain of cause, effect and impact. In reality, most risks do not consist of a single chain but rather of a network. Cognitive mapping aid in reducing the complexity of a decision problem. Furthermore, given the complexity of the interrelated aspect of risk, farmers often perceive a loss of controllability concerning a specific farm risk. By reducing this complexity, through presenting the relations between different risks, farmers can regain a feeling of controllability.

Third, cognitive maps can be useful tools to guide and improve bi-directional learning between the farming community and policy, industry and research. The boundaries previously described are important, but not exclusive in this regard. These so-called structural holes can be found in the cognitive maps of both the farmer and the researcher/interviewer/policymaker. The unstated parts of the farmer's cognitive map can exist of concepts unknown to the farmer, concepts known to the farmer but that he forgot to mention, and concepts that are known to the farmer but (in his view) deemed not relevant. First, farmers can use cognitive maps of perceived risks to interact with other farmers or consultants in order to learn about the risk and relations that were unknown for them. Second, he can be reminded of the concepts he forgot to mention. Last, researchers, extension agents and policymakers can learn about the priorities of the farmer while discussing with him the concepts het finds non-relevant (aspects that are known to the farmer but not considered as risk). The boundary of cognitive maps is informative to researchers because it directs attention to the aspects that are most relevant to the farmer (Just, 2003). Furthermore, cognitive mapping can very well be extended from the personal level to the group level (Tegarden and Sheetz, 2003), in this way group learning can be further advanced. Future research could develop the use of cognitive mapping for collective risk perceptions.

Potential limitations of cognitive mapping

Each method for elucidating risk perception has its strengths and limitations. For example, a classic risk map does not reveal the connections between different mentioned risks. The cognitive map is a representation of a mental model; a mental model, in turn, is the interpretation or model of reality and is by definition a simplification of reality (Figure 5.4) (Johnson-Laird, 1983 in Wood et al., 2012).

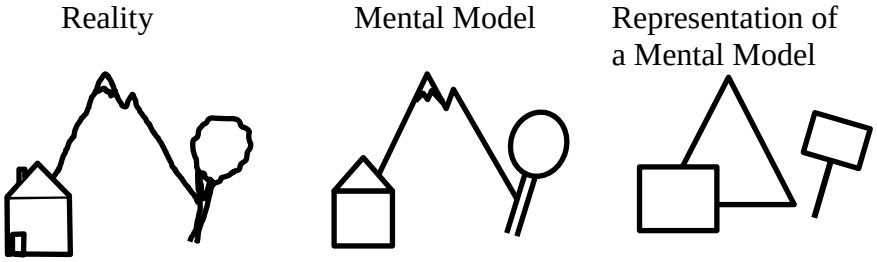

Figure 5.4: The inherent simplification of reality via perceived reality to the representation of one's mental model in communicating about one's vision of reality

As an aid to risk management, cognitive maps can suggest that all aspects and links related to a given decision need to be understood and managed to be able to make a decision. However, the loci of control may be much smaller than the information in a cognitive map suggests. The aim of the cognitive map is not to help deciding on a particular risky choice but rather to be a tool that provides the context and can be used to keep a broad perspective. When using the cognitive map as an aid in making sound decisions, as a communication tool, or as a bi-directional learning tool, one must remember that it does not have to be complete and in fact cannot be complete (Weinstein, 1999).

Three potential limitations of cognitive mapping as a tool to elucidate risk perceptions are all related to the approach used to construct cognitive maps. First, no standardized procedure and survey to construct cognitive maps yet exists, which suggests an avenue for future research. Second, the lack of standardized methodology means that the construction of the cognitive map must be done by interpreting the interview transcript. The quality of the map therefore depends on the quality of the interviewer as listener and interpreter (Eden, 2004). Third, the construction of cognitive maps is a time-consuming (Isaac et al., 2009) and expensive effort.

5.5 Conclusions

In this study, we propose an alternative method to elucidate and present farmers' risk perception that does not reflect the unrealistic prior assumptions about risk, taken by classic methods in agricultural economics. Cognitive mapping provides a methodology that allows the mapping of farmers risk perception in line with actual farmer's understanding of risk. The main strength of this approach is to elucidate the relation between the different uncertain causes, effects and impacts and to

emphasize the interrelated character of the risks. It is noticed that perception of risk is always partial, i.e. the focus is on either the uncertain event, the probability of this event happening, or the value at stake, while the risk chain or network is only implicitly regarded. Cognitive mapping provides a tool to construct the detailed overview of the entire risk network from these separate parts. Furthermore, where conventional methods fail because of their quantitative character and the farmers' difficulty in quantifying risk, cognitive mapping allows for the interrelated and qualitative perceptions of risk by the farmer. This method can be beneficial to farmers, farm consultants and researchers interested in perceived farm risk. Cognitive maps of perceived risk can enhance insights into the perceived risks and the non-perceived risks which can be used to prioritize risk management. Furthermore, cognitive maps can be used as a tool for facilitating communication about a complex subject such as risk. To put it in the words of Howard (1989, p.921) "*Knowledge maps let you say what you know and know what you say*". In the context of perceived farm risk, the largest advantage of the cognitive map is that, unlike other available tools, it elucidates the context of the perceived risk. Where other tools focus on a specific decision under uncertain conditions, the cognitive map can elaborate on possibly-related but separate impacts by outlining the relationships between different interlinked risks. Although it cannot be used on its own as a tool for making specific decisions, it provides the context needed to make such decisions. The complementarity with traditional decision tools could be investigated in further research. The combination of different tools will likely provide the information needed to make well-informed decisions.

Chapter 6

Risk attitude and choice under risk in context

Based on: Van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., Wauters, E., 2014. Context specificity of farmer's risk attitude: A factorial survey approach. *to be submitted*

Keywords: Risk attitude measures, risk behaviour, factorial survey, vignettes

Abstract: Risk behaviour is thought to be driven by an inherent orientation or attitude towards risk. Different methods try to assess this innate risk attitude, ranging from self-elucidation questions to lottery experiments and psychometric scale questionnaires. When risk attitudes are assessed using these different methods, their correlation as well as their explanatory power in real risk management are usually quite low. In this paper, we compare three methods that are commonly used to measure risk attitude: the Holt-Laury and Eckel-Grossman based lottery experiments, self-elucidation of risk attitude and psychometric scales for risk attitudes. Furthermore, we use a factorial survey approach with three different vignettes to assess the explanatory power of these risk attitude measures in a more realistic setting. The factorial survey also serves to investigate the influence of different contextual variables on risk behaviour. Despite the relatively high correlations amongst the assessed risk attitudes, they provide no explanatory power in more realistic, yet, hypothetical, risk management choices. Different contextual variables, on the other hand, do explain the likelihood to engage in the fictive marketing, financial and production risks proposed in the vignettes. We conclude that any risky choice, whether in a lottery experiment or in a more realistic setting, needs to be considered in its context. The practical use of risk attitude as a stable personality trait is therefore challenged.

6.1 Introduction

In order to understand farmers' decision making, researchers have attached much importance to farmers' attitudes (Chavas et al., 2010). Indeed, a key factor in determining how farmers respond to risk is believed to be risk attitude (Dave et al., 2007; Pennings and Garcia, 2001; Keil et al., 2000; Willock et al., 1999a; Weber and Milliman, 1997). Risk attitude, or risk preference, is the actor's willingness to take risk. Risk attitude can vary from very willing to take risk to very unwilling to take risk. A general consensus exists about risk attitude being a personality trait regarding the willingness to take risk. However, to what extent this trait can be generalized over time, circumstances, and context, and to what extent it can be elucidated, remains controversial (Cho, 2013; Hellerstein et al., 2013; Hansson and Lagerkvist, 2012; Reynaud and Couture, 2012; Weber et al., 2002).

In (agricultural) economic literature, risk attitude is typically described in the expected utility framework (Hardaker and Lien, 2010) and, as such, is regarded as stable over time, different domains and context (Dohmen et al., 2011). Risk attitude can be measured as the curvature of the utility function and explains the extent to which an increase in value affects an increase in utility. Assessment of risk attitude in the expected utility framework is often operated using lottery experiments. In social sciences, risk attitude is also seen as an important predictor for behaviour, however, a different view on what constitutes 'attitudes' is held (Willock et al., 1999b). Attitudes are considered to be influenced by knowledge, goals, family situation, farm type and other contextual factors (Willock et al., 1999b). Risk attitude is thoroughly described in psychological literature. In this field, risk attitude is assumed to be a latent construct that cannot be measured directly (Reynaud and Couture, 2012; Pennings and Smidts, 2000). Traditionally, latent constructs are measured indirectly based on the agreement of the respondent on a series of statements that are thought to be influenced by the latent construct and scored on Likert scales, referred to as psychometric scales. Within this tradition, risk attitudes are often assumed to differ over domains and even time, i.e. decision makers can be simultaneously risk seeking and risk averse in different domains (Hansson and Lagerkvist, 2012; Starks and Trinidad, 2007; Weber et al., 2002; Pennings and Smidts, 2000).

A straightforward question is how well risk attitude measures predict actual risk behaviour. One possible way to investigate this question is to compare the different measures with each other and a variety of papers have started to emerge comparing different measures of risk attitude in an agricultural context. Nielsen et al. (2013), compared eight hypothetical elucidation methods, including self-elucidated risk assessment, yield and price series derived risk attitudes, and a lottery experiment measure for risk attitude. They find a low correlation between these different measures. Maart-Noelck and Musshoff (2013), compared a Holt-Laury experiment and two risk attitude measures based on psychometric scales and find that, whereas students score relatively consistently across these different measures, farmers score rather inconsistently. Reynaud and Couture (2012) compared risk attitude assessed by two different lottery experiments, a psychometric scale

approach and self-reported risk attitudes. They find that risk attitudes across lottery experiments are significantly correlated and that the scale questionnaire reveals that French farmers' risk attitudes differ across different domains. Tanaka et al. (2010) and Bocqueho (2014) used adapted Holt-Laury lottery experiments to demonstrate that farmers, in Vietnam and France respectively, optimize utility in accordance to cumulative prospect theory rather than to EUT, i.e. farmers are risk averse in gain domains and risk seeking in loss domains and weight extreme outcomes disproportionally high. Pennings and Smidts (2000) find significant but low correlation between risk attitudes measured using psychometric scales and those measured based on lottery experiments. Furthermore, they tested the explanatory power of these measures on several observed marketing behaviours, e.g. use of formal external price management tools and the choice of less risky marketing channels. They find that the risk attitude assessed using the lottery experiment is a better predictor for real risk behaviour compared to the other measures.

We intend to contribute to this field of research by comparing different assessment methods. Furthermore, we intend to evaluate the explanatory power of these different assessment methods in a hypothetical, but more realistic farmer's risky choice. Finally, we intend to investigate the relative importance of context in making a decision under uncertainty. For these purposes, we use a vignette study to simulate a risky choice closer to the actual risky decisions that farmers have to make. In these vignettes, the respondent is asked to read a description of a hypothetical farmers' risky decision and asked to score the likelihood he will engage in this risk. This is done for 3 different situations, covering 3 possible different risk attitude domains: price, financial and production risk. Furthermore, for each situation, the farmers are asked to repeat their choice 3 times while contextual variables are varying.

The aim of this study is twofold. First, the study aims to identify the explanatory power of the different risk attitude measure in a hypothetical but more close to real-life situation. Second, it aims to explore the influence of different contextual variables on risk attitude.

6.2 Data and methods

6.2.1 Data collection

The data for this study was gathered with an online survey. An invitation for this online survey was sent out in December 2013 to 423 farmers in Flanders (the Northern part of Belgium). The farmers who had participated in the survey presented in Chapter 2 were also invited to participate in the survey presented here. Additional email addresses were acquired via two farmers' organizations. Farmers were selected based on their inclination to participate in surveys, which was indicated by the contact persons. They were not selected based on any other farm or farmer characteristics such as farm typology, farm size or farmer's age. Out of the 423 farmers that received an invitation, 139 farmers started the survey and 94

finished the complete survey. This corresponds to an effective response rate of 22%. Although the selection of the sample based on the list of farmers provided by the farming organization leads to a sample bias, this bias is relatively small because the group of farmers as a whole is fairly homogenous. Other research reports similar sample selection approaches (e.g. Reynaud and Couture, 2012).

The survey consisted of two parts. The first part elucidates farmers' risk attitudes using different elucidation techniques. The second part reveals the context specificity of risk propensity using a vignette or factorial survey approach. Hereunder, these two parts are clarified.

6.2.2 Measures for risk attitude

In the first part, different measurement methods of risk attitudes were used to obtain a variety of risk attitude measures. Risk attitude can be elucidated with a variety of different methods of which the most common are self-elucidation and lottery experiments in the economic literature, and the use of psychometric scales in the psychological literature (e.g. Reynaud and Couture, 2012). The measures included in this part of the survey were: self-elucidation of a general attitude towards risk and domain-specific risk attitudes, an estimation of the constant relative risk aversion (CRRA) using an adapted Eckel and Grosmann (2008) lottery experiment, an estimation of the CRRA using an adapted Holt and Laury (2002) multiple price list (MPL) lottery experiment (Nielsen et al., 2013), and finally measures of domain-specific risk attitudes acquired via psychometric scales.

Self-assessment of risk attitude is often believed to be unreliable, given the possible bias and strategic answers that can be expected (Reynolds et al., 2010). However, this method is still frequently used, given its low cost and ease of implementation. The self-assessment questions we asked were judged on a 7 point Likert type item. For the self-elucidation of general risk attitude, the assessment scale was ranging from "I avoid risk as much as possible" to "I enjoy taking risk". The domain-specific scales tested included the domains: financial, production, marketing and innovation. The respondents were asked to indicate to what extent they were willing to take risk in these different domains on a 7 point Likert type item ranging from "very unwilling" to "very willing". The complete questionnaire, including the self-elucidation questions (Question 1 and Question 4), can be found in Appendix 2.

The two lottery experiments are based on the expected utility framework. CRRA scores are based on the assumed utility function with the following form:

$$U = x^{(1-r)}/(1-r) \qquad [7.1]$$

In which U is the attributed utility to a value x and r is the relative risk aversion score. For both the Eckel and Grossman and the Holt and Laury adapted lottery experiments, we took a hypothetical approach, i.e. no real pay-out was given to the respondents.

The first lottery experiment is based on the lottery experiment by Eckel and Grossman (2008). Eckel and Grossman (2008) developed a simple gamble-choice task to evaluate individual's CRRA. The respondents are offered a choice set of five gambles, each with two possible outcomes with an equal probability (representing a coin flip for instance) and one sure offer. The sure offer has the lowest expected payoff and the expected payoffs of the gambles are linearly increasing as does the risk (measured as the standard deviation of the payoffs). The CRRA score is derived based on the choice of the respondents for their preferred gamble. We adapted the payoffs of the gamble choice set in such a way that no negative pay-out could occur. The design of the Eckel-Grossman based lottery experiment can be found in Table 6.1. We presented the question in a story explaining the experiment (see Question 2 in Appendix 2).

Table 6.1: Design of the Eckel-Grossman based lottery experiment, respondent needed to choose one of the proposed gambles.

	Pay-outs		Probabilities		Expected		
Gamble	**Low**	**High**	**Low**	**High**	**Value**	**Difference**	**CRRA-range**
1	100	100	0.50	0.50	100	0	r>2
2	150	75	0.50	0.50	112,50	75	0.67<r<2
3	200	50	0.50	0.50	125	150	0.38<r<0.67
4	250	25	0.50	0.50	137,50	225	0.20<r<0.38
5	300	0	0.50	0.50	150	300	r<0.20

Table 6.2: Design of the Holt-Laury based lottery experiment, CRRA range based on the gamble for which the respondent switches from the safer to the riskier gamble

	Probabilities		Expected Value			
Choice	**low**	**high**	**E(A)***	**E(B)****	**E(A)-E(B)**	**CRRA -range**
1	0.90	0.10	328	95	233	r < -1.71
2	0.80	0.20	336	170	166	-1.71 < r < -0.95
3	0.70	0.30	344	245	99	-0.95 < r < -0.49
4	0.60	0.40	352	320	32	-0.49 < r < -0.14
5	0.50	0.50	360	395	-35	-0.14 < r < 0.15
6	0.40	0.60	368	470	-102	0.15 < r < 0.41
7	0.30	0.70	376	545	-169	0.41 < r < 0.68
8	0.20	0.80	384	620	-236	0.68 < r < 0.97
9	0.10	0.90	392	695	-303	0.97 < r < 1.37
10	0.00	1.00	400	770	-370	1.37 < r

* E(A): expected value for the safer gamble (pay-outs: 320 - 400 euro)

** E(B): expected value for the riskier gamble (pay-outs: 20 – 770 euro)

The second lottery experiment is based on the Holt and Laury MPL lottery experiment adapted by Dave et al. (2007). The lottery experiment designed by Holt and Laury (2002), also known as the multiple price list (MPL), is generally accepted as the "gold standard" for risk elucidation in economic literature (Nielsen et al., 2013). This method uses a series of 10 choices between two gambles of which one is relatively safer compared to the other (lower variance). The low and high pay-outs of the gambles remain constant over the 10 choices but differ between the two gambles. The safer gamble has the least difference between the high and low pay-out (400 and 320 euro respectively in our hypothetical lottery experiment) and the riskier gamble has a much larger variance (770 and 20 euro in our hypothetical

lottery experiment). The probability of winning the high or low pay-out remains the same over the two gambles but vary over the 10 choices. In the first choice set, the probability of winning the high pay-out is 10% for both gambles. Therefore, the safer option, with a 90% chance of winning the low pay-out of 320 euro compared to 20 euro in the riskier option, is the choice with the highest expected pay-out. However, as in each following choice the probability of winning the high pay-out increases with 10%, and consequently the probability of "winning" the low pay-out decreases with 10%, the expected value of the two gambles are closing in. Moreover, expected pay-out is switching in favour of the riskier gamble between choice 4 and 5. Consequently, a risk neutral person would change his preference from the safer to the riskier gamble in the 5th choice. The more risk averse the respondent is, the more safe choice he will make. The amount of safer options chosen, or rather the breaking point on which the respondent switches from the safer to the more risky option, is an indicator for the individuals CRRA (Table 6.2). The gambles were presented using pie charts indicating the probabilities and pay-out values. This visual aid was chosen to reduce the complexity of the gamble. The full hypothetical gamble experiment is presented in annex 2 question 3. The MPL Holt-Laury experiment is slightly more complex than the simpler Eckel-Grossman experiment. Potentially, this complexity can cause a greater error in the elucidation of the CRRA. At the same time, the scale in the Holt-Laury measure is finer, enabling higher explanatory power (Dave et al., 2007).

The experiments based measures of assessing risk attitude are rooted in economic literature and assume risk attitude to be understood in the expected utility framework. We also include measures for risk attitude that are rooted in the psychological literature and assume risk attitude to be a latent factor to be measured with different Likert items. In our survey, we measured 4 domain-specific latent risk attitudes with 11 statements scored on a 7 point assessment scale ranging from "completely disagree" to "completely agree". The domain risk attitude scales are consequently calculated by averaging the items scores of the corresponding items. Cronbach alpha scores are calculated to check for the consistency of the scores over the different items.

6.2.3 Factorial survey

The influence of context on farmers' decision making under uncertainty was tested using a factorial survey approach. We opted to use the factorial survey approach because this approach is well suited to study the context and conditions influencing human judgement and the criteria for decision-making and behavioural intentions (Wallander, 2009). The factorial survey approach uses standardized vignettes, in order to simultaneously test the influence of a number of factors on the variable of interest, in our case risk propensity or risk behaviour.

Factorial survey research has its origins in the social sciences and is very similar to conjoint analysis or choice experiments, both better known in the field of agricultural economics. The aim of the factorial survey is: "*to make it possible to determine the underlying principles behind human judgements (or evaluations)*" (Rossi and Nock, 1982 p.16). The approach was developed as a reaction to the

standard survey methods, in which factors were derived by the respondents' answers to direct questions (Wallander, 2009). Instead, in a factorial survey, respondents react to a vignette which includes several variables or dimensions. For each dimension, different levels or values are specified and in each vignette, a specific combination of dimension levels is presented to the respondent. The dimensions and corresponding levels can be presented in a simple table or in a short story. The latter is opted for in this study, since it better represents a realistic situation. Examples of the vignettes presented to the respondents can be found in Appendix 2.

The total amount of possible vignettes is growing exponentially with an increasing number of dimensions and levels, for example a vignette with 4 dimensions with 3, 4, 3 and 4 levels has a total vignette universe of: $3 \cdot 4 \cdot 3 \cdot 4 = 3^2 \cdot 4^2 = 9 \cdot 16 = 144$ vignettes. Although each respondent can score more than one vignette, it is often impossible to present all realisations of the possible vignettes (specific combination of levels of the different dimensions) to each farmer. However, it is desirable that each unique vignette (specific combination of levels) is presented to more than one respondent to be able to compare unique vignettes. When a selection of vignettes is necessary, the selection procedure must be such that the selected sample is both symmetrical and orthogonal. This was established using computer algorithm to maximize D-efficiency in SAS (SAS/STAT, 2011); In the design of all three vignettes D-efficiency was 100%.

6.2.4 The risky choices and contextual factors

In our survey, we included 9 vignettes interrogating farmers about their decisions in 3 different risky situations representing three major sources of risk. Each situation was repeated in 3 vignettes. The 3 risky situations include: a decision about a new buyer, representing price risk, a decision about an investment, representing financial risk and a decision about a crop insurance, representing production risk. The complete design of the vignettes can be found in Appendix 2.

The contextual factors in these three different vignettes are specified by their dimensions and corresponding levels (Table 6.3). The dimensions were selected based on preliminary interviews and discussed with various experts from different farmers' organizations. Some of the dimensions occur throughout the three different vignettes: peer behaviour (did colleague farmers take this risk?), the source of the information about the risk (who was consulted?), governmental support received by the farmer (does the fictive farmer receive subsidy?), off-farm income (does the fictive farmer obtain an off-farm income?), current financial situation (does the fictive farmer has a loan or a buffer?), presence of a successor (does the fictive farmer know about his succession?), and source of uncertainty (what is causing the risk?). Other dimensions, such as the relationship with business partner, or reason for investing, are exclusive to the specific choice of the three different vignettes. The vignettes were discussed with experts from the farmers' organizations and adapted before they were sent out to the farmers.

Table 6.3: The dimension and levels according to order of appearance in the three vignettes

Price risk: new buyer with higher more volatile price A new buyer is offering a on average 15% higher price, however, this price is expected to be more volatile over time than the price the current buyer offers. Would you change?		**Financial risk: big investment with possibility of losing** An investment of 150.000 euro is required with a repayment time of 15 years. There is a probability of 15% that the farmer will not be able to repay. Will you make this investment?		**Production risk: insurance against yield risk** A fruit grower has the option to buy an insurance to be completely compensated for financial damage caused by catastrophic yield loss. The cost is 5-10% off the total profit. Would you buy the insurance?	
Dimension	Level	Dimension	Level	Dimension	Level
- source of information (who was consulted)*	- self-gathered - buyer - colleague farmers	- source of information (who was consulted)*	- bank - colleague farmers - family	- source of information (who was consulted)*	- self-gathered - insurance expert - colleague farmers
- peer behaviour (did college farmers take this risk?)*	- almost none - some colleges - almost all	- peer behaviour*	- almost none - some colleges - almost all	- peer behaviour*	- almost none - some colleges - almost all
- governmental support received by the farmer*	- none - some - much	- governmental support received by the farmer*	- none - some - much	- governmental support received by the farmer*	- none - some - much
- off-farm income*	- none - some - much	- off-farm income*	- none - some - much	- off-farm income*	- none - some - much
- financial situation*	- small buffer - small loan - big loan	- financial situation*	- small buffer - small loan - big loan	- financial situation*	- small buffer - small loan - big loan
- presence of a successor*	- certainly - not certain - certainly not	- presence of a successor*	- certainly - not certain - certainly not	- presence of a successor*	- certainly - not certain - certainly not
- unintended consequences	- less administration - some extra administration - much more administration	- reason for the investment	- modernization - maintaining the rentability - replacement of old capital	- previous experience	- much negative experience - some negative experience - no negative experience
- relation with current buyer	- good - problematic	- source of uncertainty**	- market prices - disease at farm - climatic risk	- source of uncertainty**	- climatic conditions - disease
		- eligibility for investment subsidy	- yes - uncertain - no		

* Dimensions which are similar across the three different vignettes

** Dimensions which are similar across two of the three vignette

The farmers needed to respond to four questions after having read each vignette. The questions were scored on a 7 point Likert type item and included: the likelihood that they would chose the riskier option (very unlikely to very likely), the perceived advantage of choosing the riskier option (very small to very big), the risk involved (very little risk to very much risk), and the control that they perceived to have over the risk (very little to very much). These questions were asked in this order and we chose to not randomize the order of the questions. The latter is sometimes done to avoid an order effect on the response. However, we did not want the respondent to be influenced by responses on the questions about perceived risk and perceived advantage when scoring the likelihood to engage in the proposed risk.

6.2.5 Analysis

In factorial survey analysis, the unit of analysis is not the respondent but the vignette. Since each respondent has completed 3 repeats per risky decision, the unit of analysis is three times higher than the amount of respondents. However, the respondent does bias the results, since it can be expected that each respondent would fill in the answers to the question of the vignettes more similarly compared to a random other respondent. We correct for this bias by estimating a random effect model of the form:

$$y_{i,j} = \alpha + \sum \beta_{k,i} x_{k,i,j} + v_i + \varepsilon_{i,j} \qquad [6.1]$$

Where y is the likelihood to engage in the risk proposed in vignette j of farmer i, α stands for the constant and x is a set of explanatory regressors of which there are a total of k, $ß$ is the associated coefficient, v is representing the farmer specific random effect and ε is the overall error term (Jasso, 2006).

6.3 Results

Below, we first present the results regarding the different risk attitude measures. The results of the factorial survey are presented next.

6.3.1 Risk attitude measures

The descriptive statistics on the risk attitude measures are given in Table 6.4. The self-elucidation questions indicate that farmers generally tend to score themselves in the lower half of the scale indicating an aversion to risk; this is especially true for the self-ranking of general risk attitude. However, when risk attitudes are assessed with psychometric scale items, scores are on average in the right-hand side of the risk attitude scale. It should be noted that, from this scale, we cannot indicate whether a farmer is risk-averse, risk-neutral or risk-loving in the technical sense. Another interesting finding is that on average the farmers ranked themselves to be most risk seeking in the domain of innovation, whereas, in the scale questions the domains of production and financial risk taking received the highest average scores.

The majority of the farmers showed consistent risk behaviour in the Holt-Laury based experiment. They chose for the low risk gamble (gamble A) in the case of a small probability of a high payoff and at a certain threshold once switched to the high risk gamble (gamble B) with an increased probability of high payoff. In total, 26 out of the 111 farmers who completed the Holt-Laury experiment did switch options more than once. These farmers were dismissed from the analysis. The average CRRA score in the HL experiment is 0.36 which is slightly risk averse. This is in agreement with most studies on risk aversion of farmers. The average CRRA score derived from the Eckel-Grossman lottery is 1.12 indicating that on average the farmers are highly risk averse (Holt and Laury, 2002).

Table 6.4: Descriptive statistics of the risk attitude measures

	n	Mean	Std. Dev.	Min	Max
Lottery Experiments:					
Eckel-Grossman	115	1.12	0.79	0.00	2.00
Holt-Laury	85	0.36	1.12	-2.00	1.36
Psychometric scale:					
production	106	3.08	1.44	1.00	7.00
financial	106	3.50	1.44	1.00	7.00
marketing	106	3.66	1.25	1.00	7.00
innovation	107	4.39	1.23	1.00	7.00
Self-rank:					
general	118	2.49	1.35	1.00	7.00
production	106	3.33	1.59	1.00	7.00
financial	107	3.21	1.49	1.00	7.00
marketing	108	3.55	1.50	1.00	7.00
innovation	107	3.79	1.64	1.00	7.00

Table 6.5 shows the correlation coefficients between the 11 risk attitude measures. Many pairwise correlations are significant, but their coefficients are low. The general self-ranked risk attitude is significantly correlated with all other attitude measures, apart from the financial risk attitude assessed by psychometric scale and the self-ranked risk attitude regarding innovation. The negative coefficients between both the Holt-Laury and Eckel-Grossman experiments and the psychometric scale and self-ranked risk attitudes are to be explained by the fact that they have inverse scales, i.e. in the experimental setups, a higher score indicates a higher aversion towards risk while for the self-ranking and psychometric approaches, a higher score indicates a higher willingness to take risk.

6.3.2 Contextual factors influencing risk behaviour

The analysis of multicollinearity between the regressors of the random-effect models did not indicate any sign of multicollinearity as the variance inflation factors (VIF) are all below 3 (highest VIF was 2.1 for perceived risk in the production risk vignette). The Breusch-Pagan test for homoscedasticity of the independent variables did indicate heteroscedasticity, therefore the random-effect models were performed using Huber and White sandwich estimator for robust standard errors (White, 1980, 1982; Huber, 1967). In Table 6.6, the results of the random-effect models are

shown. The coefficients of determination for the 3 random-effect models are relatively large (R2 > 0.60 for all three models), indicating a good model fit. Hereunder, the dimensions that were found to have a significant influence on the likelihood to engage in the fictive risks are described.

Table 6.5: Pairwise correlation coefficients between the risk attitude measures

		Lottery Experiments		Psychometric scale questions				Self-rank items				
		EG	HL	Prod.	Fin.	Mark.	Innov.	Gen.	Prod	Fin.	Mark.	Innov.
Lottery experiments	Eckel-Grossman	1.00										
	Holt-Laury	**0.28**	1.00									
		0.01										
Psychometric scale questions	production	-0.16	-0.12	1.00								
		0.16	*0.31*									
	financial	-0.09	-0.14	**0.27**	1.00							
		0.42	*0.23*	***0.02***								
	marketing	0.05	-0.15	-0.03	0.01	1.00						
		0.66	*0.21*	*0.80*	*0.90*							
	innovation	**-0.24**	-0.12	-0.14	0.17	**0.33**	1.00					
		0.04	*0.30*	*0.21*	*0.15*	*						
Self-rank items	general	**-0.23**	**-0.25**	**0.20**	**0.26**	0.08	0.08	1.00				
		0.04	***0.03***	***0.09***	***0.02***	*0.51*	*0.48*					
	production	-0.08	**-0.21**	0.09	**0.21**	-0.05	0.13	**0.38**	1.00			
		0.51	***0.06***	*0.42*	***0.07***	*0.67*	*0.25*	*				
	financial	**-0.20**	-0.15	0.14	**0.47**	0.06	**0.29**	0.03	**0.34**	1.00		
		0.08	*0.18*	*0.22*	*	*0.63*	***0.01***	*0.78*	*			
	marketing	0.01	-0.07	-0.11	-0.03	**0.20**	0.05	0.05	**0.26**	**0.20**	1.00	
		0.92	*0.52*	*0.36*	*0.82*	***0.09***	*0.69*	*0.68*	***0.03***	***0.08***		
	Innovation	-0.02	-0.12	-0.11	**0.25**	0.18	**0.51**	0.18	**0.32**	**0.35**	0.19	1.00
		0.89	*0.30*	*0.33*	***0.03***	*0.13*	*	*0.11*	***0.01***	*	*0.11*	

n = 76, p-value in italic, bold figures indicate coefficients with p-value < 0.10, * indicate p-value < 0.005

In the price risk vignette, we find that the variation of various contextual factors significantly (p-value < 0.10) influences the likelihood of the respondents to engage in the hypothetical risk. The respondents were more likely to take the risk and change buyer when the hypothetical farmer received information about the risk from colleague farmers rather than when it was self-gathered. The source of information is also a significant predictor for the likelihood of the respondents to engage in the financial risk, but not for the production risk. The fictive peer behaviour was only of significant influence on the likelihood to engage in the price risk. Having an off-farm income was of importance for the likelihood to engage in the price and financial risk, but not in the production risk. Having a large loan compared to a small buffer was of significant influence on the decision to engage in the financial risk only. A rather high and significant coefficient was found for having a successor for the likelihood to do the investment in the financial risk vignette, so having the certainty of a successor increased the likelihood to do the fictive investment. Previous experience with risk is a dimension unique to the production vignette and was found to be significantly associated with the choice to obtain the proposed insurance. Respondents were less likely to opt for the yield insurance in the situation in which the fictive farmer had almost no previous negative experience

with yield loss compared to the situation in which the fictive farmer had much negative experiences with yield loss. Respondents were less likely to get a yield insurance when the fictive farmer had almost no previous negative experience with yield loss compared to fictive farmers that had much negative experiences with yield loss. The fictive relation with the previous buyer is a significant predictor for the intended likelihood to change buyer in the price risk vignette. Finally, the fictive eligibility for receiving an investment subsidy is of significant influence for the likelihood to invest in the financial risk vignette.

Table 6.6: The random-effect models testing the influence of various contexts on the intended likelihood to engage in the risk proposed in the three different vignettes

Marketing risk			**Financial risk**			**Production risk**		
Variable	**Coef.**	**p-value**	**Variable**	**Coef.**	**p-value**	**Variable**	**Coef.**	**p-value**
Common contextual factors								
Source of information:	.	.	Source of information:	.	.	Source of information:	.	.
from buyer - self gathered	0.24	0.11	college farmers - bank	**-0.36**	**0.02**	expert - self gathered	-0.02	0.88
farmers - self gathered	**0.33**	**0.03**	family - bank	**-0.46**	**0.00**	farmers - self gathered	0.08	0.54
Peer behaviour:	.	.	Peer behaviour:	.	.	Peer behaviour:	.	.
some - almost none	**0.43**	**0.01**	some - almost none	0.06	0.73	some - almost none	-0.07	0.59
almost all - almost none	0.21	0.29	almost all - almost none	0.08	0.65	almost all - almost none	-0.01	0.95
Income support:	.	.	Income support:	.	.	Income support:	.	.
some - none	0.18	0.26	some - none	0.11	0.45	some - none	0.15	0.18
much - none	0.08	0.62	much - none	0.19	0.23	much - none	0.00	0.99
Off-farm income:	.	.	Off-farm income:	.	.	Off-farm income:	.	.
some-none	0.12	0.45	some-none	**0.45**	**0.00**	some-none	0.03	0.82
much - none	**0.41**	**0.03**	much - none	0.19	0.25	much - none	0.17	0.25
Financial situation:	.	.	Financial situation:	.	.	Financial situation:	.	.
small loan - small buffer	0.05	0.76	small loan - small buffer	0.01	0.96	small loan - small buffer	0.06	0.68
large loan - small buffer	-0.25	0.11	large loan - small buffer	**-0.32**	**0.05**	large loan - small buffer	0.08	0.61
Acquisition:	.	.	Acquisition:	.	.	Acquisition:	.	.
not certain - certainly	-0.25	0.19	not certain - certainly	0.13	0.41	not certain - certainly	**0.25**	**0.09**
certainly not - certainly	-0.06	0.76	certainly not - certainly	**0.64**	**0.00**	certainly not - certainly	**0.26**	**0.09**
			Source of uncertainty:	.	.	Source of uncertainty:	.	.
			epidemic - price risk	-0.05	0.75	disease vs climatic	-0.15	0.15
			climatic conditions - price risk	0.00	1.00			
Vignette specific contextual factors								
Incidental consequence:	.	.	Reason for investments:	.	.	Previous experience:	.	.
some more - less administration	-0.23	0.28	maintaining rentability - modernization	0.26	0.11	some - much negative exp.	-0.07	0.68
much more - less administration	-0.04	0.86	replacement of old capital - modernization	0.15	0.29	almost none - much negative exp.	**-0.44**	**0.05**
Relation with buyer:	.	.	Eligible for subsidy:	.	.			
problematic - good	**0.49**	**0.00**	uncertain - yes	**0.34**	**0.05**			
			no - yes	0.15	0.37			
Respondent specific factors								
Perceived risk	**-0.18**	**0.01**	Perceived risk	**-0.16**	**0.01**	Perceived risk	-0.09	0.20
Perceived control	0.04	0.55	Perceived control	**0.08**	**0.07**	Perceived control	-0.01	0.68
Perceived advantage	**0.85**	**0.00**	Perceived advantage	**0.76**	**0.00**	Perceived advantage	**0.96**	**0.00**
Constant	0.68	0.21	Constant	0.58	0.18	Constant	0.60	0.15
n	297		n	266		n	261	
R^2	0.62		R^2	0.73		R^2	0.73	

Bold values indicate p-value < 0.10

The perceived advantage in the proposed risk or allowing the risk is significant associated with the decision in all the risk prompted choices. The perceived risk is significant in the models for price and financial risk but not in the production risk model. Furthermore, the coefficients of perceived risks are much lower compared to the coefficients of perceived advantage. Perceived controllability over the risk is only a significant predictor for engaging in the financial risk.

6.3.3 Explanatory power of risk attitude measures in the vignette study

The different risk attitude measures were included in additional individual random–effect models for each measure and for the three decision vignettes. The coefficients and corresponding p-values of these regressions are presented in Table 6.7. None of the p-values is lower than 0.05 and only one p-value of the coefficient for production the marketing vignette, is lower than 0.10. Hence, none of the risk attitude measures provides a good predictor for risk behaviour in the vignette under study.

Table 6.7: The coefficients and corresponding p-values for the risk attitude measures as estimated in their individual random-effects models, in bold coefficients with a p-value < 0.10

	Marketing risk			**Financial risk**			**Production risk**		
	coef.	**p-value**	**n**	**coef.**	**p-value**	**n**	**coef.**	**p-value**	**n**
Lottery Experiments:									
Eckel-Grossman	-0.07	0.53	291	0.05	0.61	260	-0.07	0.50	258
Holt-Laury	-0.03	0.64	233	0.04	0.68	209	0.00	0.96	210
Psychometric scale:									
production	0.01	0.93	294	-0.03	0.45	263	0.02	0.66	258
financial	-0.01	0.89	294	-0.02	0.76	264	0.02	0.76	258
marketing	-0.08	0.39	294	0.06	0.31	263	0.01	0.86	258
innovation	-0.02	0.80	297	0.02	0.66	266	0.01	0.87	261
Self-rank:									
general	0.03	0.60	294	-0.02	0.66	263	-0.01	0.91	261
production	**-0.08**	**0.08**	**288**	0.05	0.39	258	-0.04	0.51	255
financial	-0.04	0.53	291	-0.03	0.64	260	0.00	0.93	259
marketing	-0.01	0.81	294	-0.10	0.11	263	-0.04	0.47	261
innovation	0.01	0.86	292	0.00	0.96	263	0.00	0.95	258

6.4 Discussion and conclusions

6.4.1 Risk attitude measures

Risk attitude is believed to be an important predictor of risk behaviour and different measures are available to derive an innate risk attitude. Various studies exist within the agricultural context that compare risk attitudes measured in different ways (e.g. Maart-Noelck and Musshoff, 2013; Nielsen et al., 2013; Reynaud and Couture, 2012; Pennings and Garcia, 2001; Pennings and Smidts, 2000). In general, a low consistency between the different measures elucidating risk attitude is observed. Likewise, in this study, correlation analysis showed low consistency between the different measures of risk attitude.

One explanation for this low consistency between the different measures of risk attitude has to do with the difficulty to measure risk attitude. Risk attitude is a latent construct and cannot be measured directly. Undeniably, not a single risk attitude measurement method measures risk attitude directly, but rather measures stated or revealed risk behaviour. The underlying assumption of these methods is that an individual is consistent in its reaction towards risky situations. This consistency is assumed to be caused by a general orientation towards taking or avoiding risk (Sitkin and Pablo, 1992 in Keil et al., 2000; Harnett and Cummings, 1980; Kogan and Wallach, 1964). Indeed, it is plausible to assume that one's assessed reaction towards risk, e.g. in a lottery experiment, is driven by an inherent risk attitude and can act as a predictor for other behaviours under risk. However, risk behaviour is, at most, a good proxy for risk attitude and as Willock et al (1999b p. 287) pointed out: "*attitudes on their own are poor predictors of behaviour".* Indeed, attitudes are, as predictors for behaviour, complemented among others by habits, norms, and expected influence on the outcomes.

Furthermore, risk attitude differs across domains and thus the risk attitude measured in one domain is not correlated to a measure of risk attitude situated in another domain (Hansson and Lagerkvist, 2012; Weber et al., 2002). Consequently, risk attitude assessed by e.g. a lottery experiments does not reveal an innate general orientation towards risk, but an attitude towards financial risk taking in the context of the proposed gamble. Likewise, all other measures provide attitudes that are only valid in their corresponding context. As such, risk attitudes assessed by different methods will not necessarily show a high correlation with each other. Moreover, Kandasamy et al. (2014) found evidence for physiologically induced shifts in risk taking. They found that risk taking is influenced by cortisol levels and since these levels are highly volatile, a stable preference for risk cannot hold.

6.4.2 Risk attitude measures as predictor for real risk

Different measures of risk attitude have been used to predict risk behaviour in real-life situation, in particular risk attitude assessed by Holt-Laury lottery experiments and other similar lottery experiments. However, these measures are poor predictors of farmers' risk management (Hellerstein et al., 2013). Indeed, the findings in this study support the findings of Hellerstein et al. (2013 p.823) that: *"lottery choices do not reveal deep-seated risk aversion; that is, they do not uncover a fundamental risk aversion parameter".* Although some studies do indicate that lottery experiments have a considerable explanatory power in risk decision making in other contexts, there are too few studies to validate the empirical regularity of these measures (Hellerstein et al., 2013).

Besides, risk behaviour is based on farmers' believes about the risk and hence shaped by their risk perception. Hence, any change in the context in which a risk takes place can influence the risk behaviour directly or indirectly, by being mediated via perception. Indeed, it has been shown that differences in risk behaviour can be attributed to both different risk attitudes and different perceptions of the involved risk (e.g. Weber et al., 1998; Weber and Milliman, 1997). Therefore, different reactions to a lottery experiment, or different scores in a

psychometric scale questionnaire designed to measure risk attitude, might indicate a different perception of the risk rather than a different attitude towards risk. In this study, risk perception did have a large explanatory power in two out of the three hypothetical farm decisions.

The result, that the perceived risk significantly influences the likelihood to engage in the risk, is seemingly contradictory to the findings of the study presented in Chapter 3. In Chapter 3, the perception of major farm risks did not have substantial explanatory power on the intention to adopt different risks strategies. Probably the connection between the intended use of the risk strategies and the perceived risks were not specific enough to observe significance. The perceptions of the risk directly related to the decision did influence the risky choice as we saw in this study. Hence, assessed perceived risk might only influence decision making in a very specific context. This is compatible with the findings in Chapter 5, that perceived risks are not reduced to classes based on the sources of uncertainty, but rather are context bound and interlinked.

6.4.3 Context specificity of risk behaviour

The results must be confronted with the previous findings that risk attitude measured using context-free measures does have a significant explanatory power over the intention to use general risk strategies, as shown in Chapter 4 and Chapter 3. When a context is provided to the decision maker, simulating a more realistic setting, these general risk attitude measures do not have a significant effect on the risky choices. This result is consistent with the findings of Harrison et al. (2007a), who find that the use of lottery experiment provides a reliable measure of risk attitudes for behaviour with low background risk or minimal contextual uncertainty, but unreliable measures for more realistic settings with contextual uncertainty. Indeed, risk management in a more realistic setting should be treated as a complex decision in a larger context (Chapter 5) and not as an isolated decision (Hellerstein et al., 2013). Only a few studies in agricultural risk taking focus on this context (e.g. Fausti and Gillespie, 2006) and with our study we wanted to provide an explorative insight in the importance of different contextual variables on risk taking.

We found the largest influence of contextual variables in the fictive marketing decision (simulating price risk) and financial decision. Peer behaviour was found to significantly influence the likelihood to engage in the hypothetical price risk. Indeed, the influence of peer behaviour on risk taking has been established previously (Gardner and Steinberg, 2005). When their peers are engaging in a risk, it is more likely that individuals also engage in the same risk. Also the relations with the business partners of the farmer play an important role in taking or avoiding risk. This finding, significant in the random-effect model presented in this study, was also observed in interviews with the farmers. Trust in business relations, but also in colleague farmers can enhance risk taking when they inform about the risk. The knowledge about acquisition is a contextual variable that is of great importance of farm management. We found, not surprisingly, that in the decision to invest in the farm, the information of whether or not the farmer has a

successor is playing a significant role. However, the sign of the (incidentally high) coefficient is perhaps unexpected. If the hypothetical farmer is certain of a successor, the respondents were less likely to engage in the financial investment compared to when the fictive farmer was certain that he had no successor. This seemingly contradictory results is explained by Calus et al. (2008, p.38): "*The average economic farm size increases and this can entail a high financial burden for the successor".*

Having an off-farm income positively influences risk taking in both the financial and price vignette. Indeed, obtaining an off-farm income stabilizes the household income, hence, the willingness to engage in business and farm risk would increase, as supported by the household risk balancing hypothesis (de Mey et al., 2014; Wauters et al., 2014). On the contrary, the role of the current financial situation was not significantly influencing risk taking in the hypothetical farm management decision. Only for the financial vignette, having a fictive big loan, rather than a buffer, made the respondents less likely to engage in the putative investment. Furthermore, whether or not the fictive farmer obtained income support was of no significant influence in any of the vignette's decisions. This result is compatible with the findings in Chapter 4, that no evidence for crowding out effects on intended implementation of different risk strategies by received subsidies was found.

6.4.4 Advantages and limitations of factorial survey research

The factorial survey approach offers a variety of advantages. First, the multi-dimensional design allows simulating the complexity of real world decisions. Second, since an evaluation is given on a combination of different variables, the probability for social desirability is lower compared to direct questioning. Third, it makes it possible to separate contextual influences that are entangled and connected in reality. Fourth, being a quantitative method, it allows testing hypotheses on a large sample. Fifth, since the vignette is the level of analysis, a large case number is gained even with relatively few respondents. However, since respondents fill in multiple vignettes, there might be a learning effect or fatigue so this is a possible downside of the method. In our survey we included a relatively low number of vignettes to prevent this fatigue effect.

Nonetheless, the factorial survey method is a promising method to explore the complex and intertwined influence of context on decision making and the application are very diverse. For example, the influence of context on investment decisions, or choice of yield contract, could be explored. Although still hypothetical, we believe that this method can yield more realistic, hence more applicable results.

In short, we did a factorial survey among 94 farmers from Flanders, Belgium, elucidating their risk attitude(s) with multiple elucidation methods and tested the validity of these measures. The validity was assessed based on their pairwise correlations and their capacity to act as predictors for the risk prompted choices in a vignette study. We found that the correlation between the different measures is quite low. Moreover, the explanatory power of risk attitude in the vignette study is very low. This suggests that risk attitude measured in a relatively narrow setting is

not a good predictor for risk propensity in a more realistic and specific setting. As long as the decision is general and broad, risk attitude might be a good predictor, but in very specific and more realistic contexts, the general risk attitude measure has very little explanatory power.

Chapter 7

Conclusions

7.1 The research process

The unifying theme of this doctoral dissertation is the understanding of how farmers cope with risk. The presented studies have an empirical and methodological focus. The dominant methods used for studying risk in agricultural economic literature on risk do not adequately consider the complexity of decision making. The presented studies aim to better understand actual decision making under risk. While pursuing this aim, this doctoral dissertation presents new methods that yield alternative insights on risk perception, risk attitude, their mutual links, and their link with risk behaviour.

To present a logical narrative across the various Chapters of this doctoral dissertation, a conceptual framework was constructed to explain that risk behaviour can only be understood when both risk perception and attitude toward risk are better understood. The perception of risk comprises more than simply the information transfer of knowledge about "objective risk". Peoples' mental models, which are frameworks for understanding the world, filter the incoming information influenced by many contextual variables. Furthermore, the conception of risk is not uniformly understood and farmers have a dynamic conceptualization of risk. Finally, the attitude towards risk is often approached with too general models.

The overall research process started with a rather traditional approach. Similar to many other studies in agricultural economics on risk, an exploratory analysis, with a probabilistic approach rooted in the psychometric paradigm, was taken. In such an approach, assumptions about risk as being categorical and probabilistic are taken for granted and are rarely investigated. However, actual decision making is more complex; for example, perceptions of risk are often interconnected and non-probabilistic.

This conclusive Chapter is structured as follows: First, in section 7.2, a classification of risk in three different groups is given. This classification facilitates the discussion of the results of the empirical chapters. In section 7.3, the lessons learned in the individual Chapters are congregated to answer the questions stated in the introduction. Apart from the empirical contribution, this dissertation aimed to contribute to the literature by exploring possible new methods to study the actual understanding of, and coping with, risk by farmers. The methodological contribution of this dissertation is discussed in section 7.4. The practical implications are considered in section 7.5. Finally, the limitations of the work and ideas for future research are discussed in section 7.6 before section 7.7 concludes.

7.2 A classification of risks

Before the contributions of the research in this dissertation are presented, a classification of risks is presented in this section. This classification intends to clarify the discussion of the results and will be referred to in the sections below.

This classification of risk is based on an eminent statement by former US Secretary of Defence Donald Rumsfeld, who gave a briefing about the alleged weapons of mass destruction in Iraq, in February 2002*: "… there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns: the ones we don't know we don't know*". The literature on risk assessment and risk management has since incorporated these three classes in their categorisation of risks (Pawson et al., 2011; de Grey, 2008; Loch et al., 2007; e.g. Chapman and Ward, 2004; Ward and Chapman, 2003). Hereunder, the classification of risk in known knowns, known unknowns and unknown unknowns is explained.

The first group of risks, the *known knowns*, are the "*small*" risks (Hardaker and Lien, 2010) with a short time span (Just, 2003), for instance price volatility or production decisions. These are typically studied using frequency approaches; that is, based on historic volatility, future risk is predicted. The risks that can be analysed with frequency approaches are all short-term small risks that have known volatilities and for which the possible consequences are understood. Given the availability of frequency data, these small risks are the focus of most scientific publications on farm risk (Hardaker and Lien, 2010).

One possible problem with these frequency approaches is that historical volatility does not necessarily predict future risks (Hardaker and Lien, 2010; Just and Pope, 2003; Norris and Kramer, 1990). Furthermore, an over-focus on risk for which frequency data is available will reduce the research scope to only a selected group of risks out of the total range of threats farmers face (Just and Pope, 2003; Norris and Kramer, 1990). Longer term risks, such as risk associated with large investments (in land, buildings or modernization of the farm), strategic changes in production, decreasing subsidies, or decreasing margins over longer time horizons, receive less attention. Similarly, all catastrophic risks or risks associated with sudden change, such as risk caused by natural disasters (long term droughts, floods, and extreme weather), epidemics, collapses of markets, or incapacitation of the farm manager, will be easier overlooked. Simply because risk data is not as readily available for these other types of risk, they may be neglected (Hardaker and Lien, 2010).

The second group of risks, referred to as the *known unknowns,* include the risk that Knight (1921) memorably classified as true uncertainty: uncertainty without known probabilities. Hardaker and Lien (2010) propose that these risks could be assessed with subjective probabilities, i.e. the perceived likelihood that individuals attach to the occurrence of risky events. It is promising that through assessment of subjective probabilities, studies on risk can be extended to include risks for which frequency data is unavailable (Just, 2003). The subjective probability approach is in line with the studies presented in Part I of this dissertation.

In Chapter 5 of this dissertation, it was shown that farmers have problems with categorising and quantifying the majority of risks. This implies that, at least for a large part of the risks, subjective probability approaches are not applicable. This

brings us to the third category of risk, the *unknown unknowns*, which includes the risks that are unexpected or for which the effect cannot be foreseen due to unanticipated interconnectedness with other risks. Van den Berg (2000) argues that many risks fall into this category. Whereas these risks cannot be categorised nor quantified, the traditional approaches cannot cope with these risks.

7.3 Empirical contributions

The main aim of this dissertation is to contribute to a better understanding of actual risk coping by farmers. It is argued that both risk attitude and risk perception should be explicitly regarded to better understand actual behaviour. Furthermore, it was found that context plays an important role in shaping risk perceptions and intended behaviours. This section describes the empirical findings of this dissertation based on the two main research questions that were posed in the introduction.

Research Question 1: How important is risk perception relative to risk attitude in guiding intended risk behaviour?

Part I investigates the relative importance of the perception of three major sources of risk and financial risk attitude on the intention to use common risk strategies. It is found that risk attitude is of relatively more importance compared to the three perceived major sources of risk; that is, the general perceptions of risks are not significantly related to the intended use of risk strategies, whereas risk attitude is. However, in Chapter 6, quite the opposite is found, i.e. risk attitude has no significant effect on the choice under risk, while risk perception does.

Studies on the relative importance of risk perception and risk attitude as determinants for behaviour, both within and outside of agricultural economics, have found similar mixed results. For example, Ulleberg and Rundmo (2003) conducted a study that is comparable to the study presented in Chapter 3. They took a psychometric approach to assess the relative influence of risk attitude versus perceptions of the risk of being involved in a driving accident on (risky) driving behaviours (such as speeding and violations of traffic rules). Like the results in Chapter 3, they found that risk attitude is significantly related to risky driving behaviour, but risk perceptions are not. On the other hand, the finding of Chapter 6 that risk behaviour significantly depends on risk perception and not on risk attitude is also corroborated by other studies (Weber, 1997; Saha et al., 1994; e.g. Cooper et al., 1988). These seemingly contradictory results can be attributed to three aspects that substantially differ between the studies: i) the operationalisation of risk perception, ii) the manner in which perceived risk is related to intended risk behaviour, and iii) the context specificity of risk attitude. Hereunder, these aspects and their influence on the role of risk perception and risk attitude on intended behaviour are further discussed.

The operationalisation of risk perception

In Part I, risk perception is operationalised as the multiplication of perceived probability and the corresponding impact of several sources of risk. As such, it is assumed that farmers can score the probability of occurrence and impact of different categories of risks. This approach is adapted from the traditional approaches towards risk that are often modelled on gamble experiments, which consider outcomes as the combination of probability and stake (van den Bergh et al., 2000). In these traditional approaches, risk is commonly assumed to be is categorical and quantitative (Rottenstreich and Kivetz, 2006), but this assumption is rarely tested. In fact, this operationalisation of risk perception seems conflicting with how risk is actually perceived. Indeed, Ulleberg and Rondmo (2003), confronted with the similar finding that risk perceptions are not significantly associated with risk behaviour whilst using a comparable operationalisation of risk perception, question the reliability and validity of the measure and hence the assumption behind it.

In Chapter 5, a grounded theory approach was taken to investigate the farmers' actual perception of risks, without making these and other prior assumptions. From this study, we learned that it is unnatural for the farmers to categorise, list and quantify risk. Risks are not perceived in isolation, but rather are embedded in their context and interrelated with each other. Interference in one risks, might develop or amplify another risk. Moreover, similar to the observations from bounded rationality theory, it was found that farmers have multiple, sometimes conflicting, goals or values at stake (Simon, 1959). This makes it hard to quantify both the probability of an occurrence (due to the interconnectedness of risks) and its impact (as a result of multiple conflicting goals). Therefore, the finding that risk perception is not significantly related to intended risk behaviour, as outlined in Chapter 3, can simply be attributed to the operationalisation of risk perception.

The connectedness of the perceived risk and the intended risk behaviour

The second aspect that explains the different findings in Chapter 3 and Chapter 6, is a difference in the manner in which the perceived risks are related to the surveyed intended risk behaviour. The perceptions of the major sources of farm risk, surveyed in Chapter 3, were not directly related to the intended adoption of common risk strategies. In other words, none of the surveyed strategies are specifically aimed to manage the surveyed perceptions of risk sources. Or, the opposite, the perceived major farm risks cannot be managed with any one particular strategy. In Chapter 6, risk perception is operationalised as the perceived threat of engaging in a well-described risky endeavour. The perceived threat in Chapter 6 is directly related to the intended behaviour. If we relate this finding to the perception of risk as elucidated with a cognitive map (see Chapter 5), risk perception as operationalised in Part 1 focuses on sources of uncertainty, while risk perception as operationalised in Chapter 6 focuses on the consequences of risk.

Another difference is that in Chapter 3 the risks perceived are non-specific, or general beliefs, while in Chapter 6 specific risks embedded in a context risk decision

environment are considered. The observation that specific risk perception has a different association with intended behaviour compared to more general beliefs has been described in other research (e.g. Connor et al., 1999) and is similar to findings on the difference between conditional and unconditional risk (Pligt, 1998). Unconditional risk refers to the situation where the factors that are taken into consideration are not specified, whereas conditional risk refers to the situation where specific action is taken (Pligt, 1998). As such, the general risk perception and major common risk management strategies studied in Chapter 3 are an example of unconditional risk, while the specific and contextualized risk problems in Chapter 6 provide an example of conditional risk. Conditional risk perceptions are more likely to influence behaviour (Pligt, 1998), which is in line with this dissertation's findings on the significance of the relation between risk perceptions and intended risk behaviour.

The context specificity of risk attitude

Whereas risk perception is significant in Chapter 6 and not in Chapter 3, the opposite holds for risk attitude. In Chapter 3, the measured general innate risk attitude was significantly related to the intended use of common risk management strategies. However, in Chapter 6, the various risk attitude measures were not significantly related to the decisions to take or avoid risk.

This finding can be attributed to the fact that risk attitude is a higher order characteristic and cannot be measured directly (Pennings and Garcia, 2001) risk attitude is always assessed indirectly either based on revealed or stated risk behaviour and always given the specific context. Ajzen and Fishbein (1980) stresses the importance of the specificity of the context in predicting behaviour. For example, it is found that risk attitudes are good predictors for a range of general behaviours, but are not very good in predicting specific behaviour (Sitkin and Weingart, 1995; Weigel and Newman, 1976). This could be attributed to a difference in the way that people deal with hypothetical versus realistic context, caused by the difference in symbolic representation versus the representation of real-life situations (Ajzen et al., 2004). Also, Weber (2002) suggests that risk attitudes change with the content of the decision. In Chapter 6, the context of the decision is varied by design of the factorial survey, which elucidates the fact that the general risk attitude measures used are not adequately explaining the choices of the farmers to take or avoid the surveyed risks.

Furthermore, a change in behaviour could be due to a change in risk attitude, but may also be due to another (confounding) variable that influences risk behaviour for example the perception of the risk. Indeed, Weber and Milliman (1997) propose that differences in taking or avoiding risk can be ascribed to an overly optimistic or pessimistic perception of risk, rather than differences in attitude towards risk. For instance, March and Shapira (1987) distinguish between situations in which the decision makers perceive to be in control of a risk and situations in which they are not. In situations of perceived control, the decision is driven by perceptions of risk rather than risk attitude. This conclusion aligns with the findings presented in this

dissertation, as the perceived control of the risk was much lower in Chapter 3 than in Chapter 6.

Research Question 2: How does the decision context influence the decision?

From the Seemingly Unrelated Regression (SUR) analysis described in Chapter 4, it appears that the socio-psychological variables had more impact on the intended use of the risk strategies compared to the impact that the different farm characteristics had. However, none of the regressors were significant in all the (eleven) equations. Hence, no uniform determinant for the intended adoption of risk strategies was found. Moreover, the total variance explained was low, despite the large number of regressors. This indicates that other determinants, which are more specific to the farmer (or the farm situation), might be better predictors for farm management (Meuwissen et al., 1999). It was, therefore, concluded that risk and risk taking should be assessed within a more specific context.

It is increasingly acknowledged that context plays a major role in decision making under risk (Weber et al., 2002; Goldstein and Weber, 1995; Bromiley and Curley, 1992). Furthermore, a large body of evidence suggests that risk attitudes differ between different decision domains (Hansson and Lagerkvist, 2012). In Chapter 6, the influence of different context variables on decision making under risk was assessed. The context variables were, in some cases, significantly related to intended behaviour. A change in context often reflects a changing perception of risk, which mediates a change in intended risk behaviour (Sitkin and Weingart, 1995). However, the analysis included the perception of risk as a control variable. Hence, the context variables are also associated to the intended behaviour without mediation of risk perception. It could be that contextual variables influence risk behaviour, mediated by alternative goals other than risk management. For example, maintaining good relations with business partners is not only in the best interest of risk management but also creates a friendly and positive working environment.

The sources of information used to decide on the decision and peer behaviour provide two different context variables that were particularly strongly related to intended behaviour. When the farmer in the vignette of the factorial survey gained information by speaking to his family or relied on self-assessment, the risks were perceived smaller. This finding is similar to that of Goldstein and Weber (1995), who found that people tend to underestimate risks based on their experience, whereas they overestimate risks based on description of the risk problem. The difference relates to different methods of assessing the risk, in the first an intuitive assessment based on own experience and in the latter a quantitative assessment based on given probabilities (Nuthall, 2012; Rottenstreich and Kivetz, 2006; Goldstein and Weber, 1995). Furthermore, decisions are often guided by social norms rather than individual goals or targets (Thøgersen and Gärling, 2001). The theory of reasoned action (Ajzen and Fishbein, 1980), and the theory of planned behaviour (Ajzen, 1991), are central theories in the social sciences that explain how attitude influences behaviour (Weber et al., 2002). In these theories, intended behaviour is determined by attitudes, subjective norms and perceived behavioural

control (Ajzen, 1991). How these and other context variables exactly influence risk behaviour remains an illusive topic for investigation.

7.4 Methodological contributions

The second aim of this dissertation is to propose and test alternative methods to investigate the actual understanding of risks.

7.4.1 The need for new methods

The choice of methods and data availability have been a major influence on the type of risks that has been predominantly studied in the last decades (Hardaker and Lien, 2010; Just, 2003). The majority of studies on risk in agricultural economics have focussed on the *known knowns*, using frequentist approaches to calculate objective risks (Hardaker and Lien, 2010). In these approaches, the perception of risk is typically not assessed. Only a few studies take the perception of risk into account, and go beyond risk questions for which frequency data is available (Norris and Kramer, 1990). These studies all fall into the *known unknown* type of risks that can be categorised and quantified. However, as the uncertainties beyond the probabilities should be taken into account (Aven, 2010a), there is a need for alternative methodologies that are equipped to deal with the non-quantifiable risks: the *unknown unknowns* (Wilson et al., 1993). This is particularly pertinent, since those risks, the long-term risks and catastrophic risks, are most relevant for farm managers, extension agents and policymakers (Just, 2001).

Reductionist approaches, such as those framed in the expected utility framework, are valuable for theoretic progress, but are often not applicable in more realistic settings (Hardaker and Lien, 2010; Just, 2003). Furthermore, a very large spectrum of risks cannot be investigated simply because the methods are lacking. Indeed as Just (2003, p.156) states: "*The greatest self-imposed constraints are probably methodological*". Most of the methods that are currently used to study risk have been around since the 1970's. Today, however, we are at the forefront of a shift towards non-parametric methods (Just, 2003).

In this dissertation, the investigations into the actual understanding of risk by farmers were performed using both traditional (parametric) and innovative (non-parametric) methods. Hereunder follows an overview of the various methods used in this dissertation, together with a discussion of the features that make them into an innovative approach for investigating actual risk and risk conception.

7.4.2 Methods used in this dissertation

In general, the studies described in this dissertation are combining qualitative and quantitative methods in order to study farmers' conception of risk. Traditionally, the field of agricultural economics has not been very open to qualitative methods. Recently, however, a gradual increase in the use of qualitative methods can be observed in agricultural economic literature (Bitsch, 2005). As qualitative and quantitative methods are frequently thought of as being incompatible, mixed

methods research is still scarce. Qualitative "purists" take a constructivist approach arguing that context-free generalizations of reality are by definition impossible, particularly as the observer is always part of the observed (Johnson and Onwuegbuzie, 2004). Quantitative "purists" take a positivist view and see the world as objective and separable from the observer, consequently, context-free generalizations can and should be made (Johnson and Onwuegbuzie, 2004). In line with what Johnson and Onwuegbuzie (2004) refer to as methodological pluralism or eclecticism, this dissertation hopes to demonstrate that there is a middle ground that combines the best of both worlds.

In Chapter 5, in an effort to avoid restricting assumptions towards the conception of risk, risk perception was investigated using a grounded theory approach. Grounded theory research is not often deployed in agricultural economics. However, as, grounded theory is designed to let the concepts and relations emerge from the data, prior assumptions can be avoided (Strauss & Corbin, 1998; p. 33). The grounded theory study showed that the risk perceptions of farmers can be elucidated and presented through cognitive maps. To my knowledge, the use of cognitive mapping for this purpose is unprecedented.

Cognitive mapping provides an alternative method to study the actual understanding of farmers' perceptions of risks and counters some of the limitations of the traditional and dominant EUT-based approaches. For example, many decisions on risk are made taking a non-probabilistic mind-set (Rottenstreich and Kivetz, 2006). Cognitive mapping can elucidate the perceptions of these non-probabilistic risks, whereas traditional, quantitative, methods, such as those based on EUT and prospect theory, are limited to assess only probabilistic risks. Furthermore, cognitive mapping is adapted to map the interlinkages between different perceived sources of uncertainty and several consequences of these uncertainties. Further, it allows that farmers have multiple and conflicting goals. This is in contrast to traditional EUT based approaches in which utility is assessed and compared on a single scale. In cases of multiple conflicting goals, scoring different risks on a single utility scale leads to problems of incommensurability, i.e. it is impossible to reduce these conflicting goals in one single dimension fit for utility analysis in the classical sense (Byron, 2005; van den Bergh et al., 2000). Therefore, EUT-based approaches are necessarily reductionist, while cognitive mapping provides a more extensive and inclusive assessment. The most evident methodological advantage of cognitive mapping is that it reveals the actual perceptions of risks in the *unknown unknowns'* category. Yet, cognitive mapping cannot be used to make predictions, or as a normative tool. Besides, the qualitative, rather than the quantitative, approach to risk assessment presents advantages (as deliberated), but also poses limitations. For example, elucidating cognitive maps is a time-consuming effort and the method is not adapted to be applied on a large scale, such as in surveys. Hence, rather than replacing traditional methods, cognitive mapping should be seen as complementing these methods.

In Chapter 6, a factorial survey approach was adopted in order to identify the influence of several contextual factors. Risk attitude was measured with various

common estimation methods. It is, to the best of my knowledge, the first time that a factorial survey approach was used in the context of agricultural economics research. It has to be noted, however, that conceptually factorial survey research is very similar to conjoint analysis and choice experiments (Klein et al., 2004), both of which are commonly used in this field (Sydorovych and Wossink, 2008; e.g. Adamowicz et al., 1998). An important advantage of using a factorial survey is that, by combining different dimensions, the social desirability bias of typical surveys is controlled for by the factorial design (Wallander, 2009; Jasso, 2006; Rossi and Nock, 1982). In this respect, the factorial survey has great potential for further studies of risk attitude and risk behaviour (Alexander et al., 2013; Wallander, 2009).

7.5 Practical contributions

The third aim of this dissertation is to turn the main findings into practical implications for policymakers and to facilitate risk communication. These implication are discussed below.

7.5.1 Implications for policy

Today, a number of policy measures are directed specifically to aid farmers in their farm-level risk management. These measures are aimed at reducing volatility of yields, prices, or other ways of stabilizing income for farmers (OECD, 2009). Also, policy measures that are not directly intended to aid farmers in their risk management are having effects on farm risks (OECD, 2009). Much of these policies are based on economic or price incentives (OECD, 2009). The motivation behind price incentives is grounded in a rationality paradigm, which assumes that individuals are consistent in their behaviour and are motivated by economic incentives (van den Bergh et al., 2000). Given these assumptions, the response of farmers on price incentive can be predicted (van den Bergh et al., 2000). However, behaviour does not solely depend on economic incentives. Many other, often conflicting, goals are pursued, as shown in Chapter 5. As such, predicting behaviour based on price incentives leads to problems of incommensurability (Byron 2005, van den Bergh, 2000). The bounded rationality approach (see paragraph 1.5.2), acknowledges that decision makers have multiple and conflicting goals and does not assume any objective a priori (Nielsen, 2009; Simon, 1959). Furthermore, bounded reality aims at satisficing, given that maximizing is beyond our capabilities (Simon, 1959). When multiple conflicting goals are involved and trade-offs need to be considered, optimization is too difficult and one rather settles for a good enough solution (Byron, 2005). Therefore, the response to price incentive can be other than expected (e.g. Nielsen, 2009; van den Bergh et al., 2000).

One unintended effect of price incentives, which has been the object of many studies, are the 'crowding out effects' of risk measures (Kimura and Thi, 2011; Antón and Kimura, 2009). For example, minimum intervention prices could seduce farmers to specialize in growing highly profitable crops, thereby losing in diversity and flexibility (OECD, 2011a). Another example of crowding out is the effect of

single farm payments on the use of contracts and other formal (private) risk management methods (Antón and Kimura, 2009; OECD, 2006). Furthermore, price incentives disconnect farmers form market signals, such as over- and under-supply, resulting in the accumulation of costs for governments (OECD, 2011b). Finally, many risks are interlinked, for example output- and input- prices are sometimes correlated, just as production and output prices are often associated. Stabilizing one price will thus not result in the intended effect of stabilizing income. Therefore, policy should focus on a more comprehensive approach towards risk management, (OECD, 2011a, p. 1): "*Government policies should take a holistic approach to risk management, assessing all risks and their relationship to each other, and avoiding focusing on a single source of risk such as prices*.".

Furthermore, not the short-term volatilities but rather the longer-term evolutions worry farmers (see Chapter 2). Farmers are mostly concerned with risks with low frequency but high impact, rather than high frequency low impact risks. Moreover, during the interviews, some farmers referred to these high frequency low impact events, not as risks, but as 'known variability'. These risks, according to the farmers, are predictable and can hence be mitigated by good farm management. Besides, high frequency risks tend to cancel themselves out since disappointing results are countered by positive results; low prices, for example, will be followed by periods of high prices. Farmers are typically in control of these risks and do not ask for support in managing them.

Different from the 'known variability', outlined above, farmers normally consider the low incidence, high impact events as risk (Figure 7.1). These incidences are described as unanticipated events, systemic risks, or catastrophic risks, and include events like the farm manager being incapacitated (for example through a disease or occupational accident), an epidemic outbreak, or extreme climatic events that cause major losses in yields. Longer-term risks, such as prices remaining below cost price for extended periods of time, belong to this category. These risks are thought to be of much greater importance, since they may seriously hamper farm survival (Just, 2003). Farmers find it difficult to manage these catastrophic risks of low frequency and high impact, either internally or with formal market instruments (OECD, 2011b). Hence, policy should focus on assisting farmers with managing these catastrophic risks.

Such assistance could include disaster funds, subsidized insurances, and *ad hoc* support. A possible problem with *ex ante* strategies and protocols could be that farmers might expect to be assisted in case of disaster. This expectation could instigate a change in farmers' risk perceptions, causing crowding out of farm-level risk management strategies, such as the use of insurances (Kousky et al., 2013). A second potential problem lies in the systemic nature of these catastrophic risks. If disaster relief is needed, it is probably needed for a large number of farms. The cost for governments will accumulate, so flexibility and *ex post* measures are possibly better suited (OECD, 2011a).

		Impact Low	High
Frequency/ Probability	Low (Incidentally / Surprise)	• Not relevant • To little impact on farm	• Risk • Example: Disease farmer, epidemic, extreme climatic events causing major loss of yield, • Management: resilience, flexibility and adaptive capacity
	High (Everyday / Frequent)	• (Known) Variability • Examples: Price volatility, diseases in plants • Management: craftsmanship or best practice management	Not existing

Figure 7.1: A classification for risk and variability

A final remark on the implication for policy, lies in the finding about the relative role of risk perception and risk attitude on risk behaviour. Whether risk perception or risk behaviour changes risk attitude does matter especially when aiming to influence risk behaviour. If risk attitude forms the basis of risk behaviour, policy would be designed differently compared to when risk perceptions form the basis of risk management decisions (Weber and Milliman, 1997). The latter opens the possibility to change risk behaviour by educating decision makers. Policy should be aimed at facilitating and enabling education and extension about risks.

7.5.2 Risk communication

The concept of risk is not used consistently, as farmers apply various definitions for risk. Risk can refer to a probability, an uncertain event, or a value at stake (Slovic and Weber, 2002). However, a single understanding underlies these different conceptions (Yates and Stone, 1992). In Chapter 5, it was demonstrated that farmers perceive all of these aspects of risk. Apparently, the underlying network of interconnected sources of uncertainty, consequences and values at stake is too large to consider fully and farmers focus on a part of the web instead. This finding corroborates the conclusions of Yates and Stone (1992, p. 2): "*... in practice people often refer to individual risk elements as the entire risk construct, as simply risk*". Cognitive mapping can explicate what element of risk is focussed on: risk as source, risk as probability, risk as consequence, or risk as threat.

Related to this, the categorisation of risk is often very practical in order to facilitate the communication about risk. For example, in the introduction the different types of risk faced by farmers were categorised in production risk, price or market risk, institutional risk, personal risk and financial risk. The usefulness of this categorization is not contested, however, categorisation brings about some implications. Since risks are interlinked, as shown in Chapter 5, it is in reality often impossible to separate the effects that originated from different sources of risk. A well-known example is the loss of yield due to climatic conditions during the season. Since this is a systemic risk, and most farmers in the region experience the same, prices will go up. As a result, the overall consequences will exceed the expectations based on the yield risk alone. Cognitive mapping allows for a better

understanding of such intertwined risks and, as such, can serve as a communication tool. First, cognitive mapping allows the farmer to create an overview of the major threats, as well as the ways in which they impact the farmer's stakes. Such an overview is completely built from the farmer's own fragmented knowledge and perceptions, however, by constructing a cognitive map the farmer can start to appreciate the complexity of the risk, which would otherwise remain obscured. Given people's limited capacity to retain information, writing down the possible relations in a cognitive map, which outlines the main risks, can help people in keeping track of the context while making risky decisions. Second, the cognitive mapping method allows for the shared building of (extended) maps. This enables farmers, extension workers, or scientist to learn from each other, particularly about the unforeseen risks and the relations between the risks.

7.6 Limitations and future research

In this section, the main practical and conceptual limitations of this dissertation will be discussed and reflected upon. From this reflection, thoughts for future research arise.

7.6.1 Practical limitations

The aim of this dissertation is to study the relations between risk perception, risk attitude and intended behaviour. The studies investigating these relations are presented as if a causal relation of risk perception and risk attitude on risk behaviour is investigated. However, the causality of the relations was not empirically tested. Therefore, no claims about the direction of the relations between risk perception, risk attitude and risk behaviour can be made. In fact, studies exist that suggest that risk behaviour influences risk perceptions rather than the other way around (e.g. Horvath and Zuckerman, 1993). The problems for testing causality with a survey design are related to: i) omitted variable bias and other causes of endogeneity, ii) the lack of controlled manipulation of variables.

First, a major issue with establishing causality relates to omitted variable bias. It is impossible to include all possible independent variables in the analysis, simply because the list is endless. However, this means that there are unobserved variables that affect the other (visible) variables. Some of these unobserved variables are correlated with the independent variables that are considered, causing unobserved heterogeneity. In other words, the exogenous variables in the estimation are not truly exogenous. The relation between the independent variables and the dependent variable, might be mediated by unobserved variables, therefore, causality cannot be established. These problems of endogeneity are reflected in the violation of a major assumption of regression analysis, which states that the error terms are independent of the coefficients.

Second, causality can only be established in a controlled experiment where true independent variables can be manipulated. Within a survey design, which is a reflection of one moment in time, this is hard to accomplish. Indeed, another cause

of endogeneity is reversing causality. When it comes to establishing causality, the main issue is to have a good conceptual underpinning of the assumed causality; empirical evidence should be consistent with this conceptual argumentation.

Another possible limitation of the presented study is inherent to the choice to study intended behaviour by means of surveys and interviews. Ajzen et al. (2004, p.1108) noticed that: "*It is a common observation that people often fail to act in accordance with their stated intentions*". There are several reasons for this discrepancy. First, there are differences between stated behaviour and intended behaviour. Self-reported intentions and attitude are subject to a number of biases, such as strategic motives, social desirability and other self-serving bias (Dohmen et al., 2011), where social desirability bias is defined by Grimm (2010, p.1) as *"…the tendency of research subjects to give socially desirable responses instead of choosing responses that are reflective of their true feelings*". Second, intended behaviour differs from actual behaviour given the influence of perceived behavioural control (Ajzen, 1991). Another cause for the difference between actual behaviour and stated behaviour is the difference in how hypothetical situations, such as the response to a survey question, and actual real-life situations, are conceptualized (Ajzen et al., 2004).

This is also closely related to the framing bias, i.e. the manner in which a problem statement is framed (e.g. negative or positive) influences the judgement (Tversky and Kahneman, 1974). Hence, the manner in which the questions of the survey are presented influences the scoring by the respondents. Various survey questions are somewhat suggestive. Particularly, the questions on farming attitudes (Appendix 1, Question 4) and the question on the consideration of the implementation of the different risk strategies (Appendix 1, Question 8) are prone to social desirability bias. Hence, it could be expected that the scores are somewhat more positive then genuine intentions and attitudes would reflect. Additionally, the phrasing of the risk events (Appendix 1, Question 5) is often negative, hence framing the respondents to focus on the negative side of risk and neglecting that risk taking also creates opportunities. The question on risk preferences (Appendix 1, Question 7) is less prone for such bias, partly because in the design it was deliberately chosen to interchange negative and positive framed questions. Furthermore, the list of the perceptions and strategies included in the survey is necessarily limited, because of the trade-off between including more (less) questions and obtaining lower (higher) response rates. However, this problem was partly countered, by including an open question on both perceived risk and (intended) use of risk management strategies. The same limitation to this survey hold for the factorial survey. However, given the design, assessing all different variable together in a comprehensive vignette, social desirability bias is weakened (Wallander, 2009; Jasso, 2006). Finally, the measurement scales are important in how respondents score on survey items. Likert-type scales were found to better assess attitudes and behavioural intentions compared to other methods (Windschitl and Wells, 1996).

7.6.2 Conceptual limitations

In Chapter 6, it was found that peer behaviour is a significant predictor of the farmers' choice. Such a finding fits the models that focus on the interaction between individuals and the models that assume that social process and cultural factors shape individual behaviour (Elster, 1989). In the context of decision making under risk, cultural theory (Douglas and Wildavsky, 1982) offers such an approach. Approaches like cultural theory, that assume methodological holism, are opposite to approaches assuming isolated individuals or methodological individualism, typical for neo-classical economics (van den Bergh et al., 2000). The presented studies in this dissertation are also based on the assumption that the farmers make decisions independently.

Furthermore, the studies in this dissertation assume that decision makers choose consciously to take, avoid or manage risk. The possibility of conflicting goals and the impact on risk management was not explicitly regarded. Farmers make operational and strategic decisions that influence the risk-return outcome of the farm; many of these decisions do not have risk management as a particular objective. For instance, off-farm income may be derived to stabilize income, but also to get out of the own farm environment and strengthen social relations. Optimizations on the farm can be pursued for the purpose of managing certain risks, but also to ease manual labour. Diversification of farm activities may be done to spread income and yield risk, but also for personal value and contentment derived from having a varied occupation. From Chapter 5, we learned that different sources of uncertainty and value at stakes are intertwined and risk management for one risk could be the source of another one. In Chapter 6, we have tried to partly take into account this complexity by being very specific about the risky choice and provide a contextual background against which the decision to take or avoid risk can be weighted. Indeed, many decisions are not made consciously, but are based on unconscious and sometimes non-purposeful actions (van den Bergh et al., 2000). Finally, many risks are managed intuitively (Nuthall, 2012).

The above mentioned assumptions pose limitations upon the scope and studies presented in this dissertation and the presented results should be interpreted with some reservation.

7.6.3 Future research directions

Based on the assessed subjective probabilities and perceived impacts of the surveyed risk events in Part I, it can be concluded that farmers in Flanders worry most about price risk and availability of land and not so much about production risk. This finding is based on a survey and as such, is subject to a number of biases mentioned in the subsection above. However, one should reflect on the use of averages in the analysis. Although averages give a first indicator about the sector, risk averages do not tell so much about individual farms and farmers. This aggregation bias is especially pronounced regarding the production risk. Yields are very specific to spatial conditions (soils, climate, etc.) and the aggregation of yields over large areas tends to decline the average variability (Popp et al., 2005; Rudstrom

et al., 2002). This aggregation bias, for yield- and other risks, should be taken into account and future research should focus on the assessment of farm-specific risks.

Furthermore, in Chapter 2, it was established that farmers in Flanders are in general slightly risk seeking, contrary to the general belief and previous research in other developed countries (Hansson and Lagerkvist, 2012; Reynaud and Couture, 2012; Kumbhakar and Tveterås, 2003; e.g. Bard and Barry, 2000; Backus et al., 1997). A limited number of studies find a similar, slightly risk seeking attitude of farmers based on self-assessment questions (e.g. Bard and Barry, 2001) and there is no general consensus on the subject (Backus et al., 1997). The finding that farmers are risk seeking is congruent with the decision to engage in such a risky business as farming. In fact, the large support for risk averse behaviour is, in this perspective, somewhat surprising and even contradicting. For example, Kumbhakar and Tveterås (2003) measure risk attitude under salmon farmers in Norway. They write that they explicitly choose salmon farmers because (Kumbhakar and Tveterås, 2003, p. 289): "*…salmon farming for an application is quite appropriate because the production process is inherently risky. Salmon farming is riskier than e.g. beef and poultry production*". However, in the same paragraph they write: "*All salmon farmers in the sample are found to be risk averse*".

The measures used to conclude that farmers are risk averse, usually measure attitudes towards risk relative to the situation the farmer are in already. Relative importance of risk is described in ranking methods such as in rank dependent utility (Quiggin, 1982) and cumulative prospect theory (Tversky and Kahneman, 1992). Also the reference point dependence in prospect theory could be seen as a means to adapt a measure for risk attitude given the current situation. However, marginal risk attitude has not found much attention in literature. Just and Lybbert (2011) are the first to propose a measure of risk attitude based on incremental adjustments of risk rather than absolute risk faced by a decision maker. Acknowledging that individuals base their decision on marginal attitude towards risk might lead to better predictions of decision making (Just and Lybbert, 2011). Future investigations should take this marginal risk attitude more explicitly into account.

In order to manage risk, farmers expect more benefits from internal risk management rather than from external tools, like extra-legal insurances, contracts and future markets (see Chapter 2). Ironically, these latter are the risk management strategies that are typically investigated in agricultural economics (e.g. Enjolras et al., 2012; Velandia et al., 2009; Sherrick and Barry, 2004; Mishra and El-Osta, 2002; Knight et al., 1989; Shapiro and Brorsen, 1988). Therefore, internal risk management strategies and the effect of risk balancing deserve further research. Finally, long-term risks, risks that cannot be quantified and the unanticipated risks and their effects have not received much attention of agricultural economists. An important reason for this neglect is the limitation of available methods. However, exactly those risks are pertinent, hence the need for investigating and exploring alternative methods remains.

In Chapter 3 and 4, it was found that risk attitudes are significantly related with the intentions to implement risk management strategies. This relation is not necessarily negative, i.e. a lower acceptance of risk does not inevitably result in a higher likelihood to adopt risk management strategies, and equally, a higher willingness to take risk is not consistently associated with a lower intention to implement risk management strategies. Rather, different risk management strategies are applied by different types of farmers, i.e. risk-averse farmers versus farmers that are willing to take risks. The risk strategies negatively associated with risk attitude include reactive strategies. These risk strategies do not target specific risks but prepare the farmer to cope with a range of general risks. The strategies that were positively associated with risk attitude were proactive strategies, allowing the farmer to prepare himself against specific risks such as production risks or price risks. This finding that preferred use of strategies differs between risk seeking and risk-averse farmers, deserves further investigation.

Risks are interconnected and therefore, managing one risk has implications for managing other risks. Furthermore, the decision to manage risk is based on the consideration of multiple risk managing strategies simultaneously. Hence, we should step away from managing particular sources of risk but focus on a holistic management of risks. Although it is not evident to study risk, taking into account these interrelations, new models should seek to take these in consideration (Just, 2001). Such holistic risk management options are closely related to concepts such as resilience. Managing resilience means making sure that a viable farm business can be sustained in an environment that is ever changing and subject to inevitable shocks, or put in a metaphor, managing resilience is not about trying to prevent storms from happening but making sure that it can storm. Resilience offers an interesting framework to explore risk management, in light of the findings that risks are connected and cannot be managed separate from each other.

7.7 General conclusions

This dissertation departs from three observations. First, it is observed that in the agricultural economic literature, many of the studies investigating risk are framed in a paradigm of efficiency and profit maximization, and by extension they employ the expected utility framework. Second, it is observed that the models rooted in this paradigm are based on unrealistic assumptions and fail to predict actual behaviour. Third, it becomes increasingly evident that investigating behaviour and behaviour intention in a realistic complex environment should start with a good understanding of risk perceptions. In most of these rational decision models, risk perception is operationalised as subjective probabilities and is not explicitly considered. These traditional methods, rooted in expected utility approaches, are no longer sufficient to investigate the actual processes and mechanisms of coping with risk.

This dissertation explores farmers' intended behaviour under risk, employing alternative methods in order to avoid being hampered by the limitations of the

traditional models. Furthermore, the aim was to investigate risk perception closer to the actual understanding of risk by farmers. Hence, a conceptual framework was proposed and empirically tested exploring intended risk behaviour as mediated by both risk perceptions and risk attitude. It was found that in a generic decision environment, risk attitude is significantly associated with intended risk behaviour, while for more context specific decisions, risk attitude measures are no good predictors for intended risk behaviour. This finding can be explained by the different manners in which people deal with hypothetical versus realistic contexts. Risk perceptions were found to be significantly related to intended risk behaviour only if the perceptions were closely related to the intended risk behaviour.

This latter finding can be understood in the light of the insights this dissertation presents about the perception of risk. Risks are perceived not in isolation but embedded in a comprehensive network of perceived uncertain events, consequences and values that are at stake. In such a framework, categorisation of risk is rather difficult and arbitrary given the connectedness of risk, and quantification of risks is nearly impossible. If the focus on risk is on the perceived sources of uncertainty, the connection with the possible consequences of any (risk)behaviour interfering in the network, is obscured by the many interrelations with other risks. Therefore, the relation between perceived risk and intended behaviour is only significant if risk perception is operationalised as the possible consequence of a risk management action.

The networks of risk perception can be elucidated and presented using cognitive mapping. This method has some substantial advantages compared to traditional quantitative methods. Two main advantages are: First, it is a qualitative method that allows mapping non-probabilistic risks. Second, it allows mapping the complexity of the decision making environment, where many risk are interrelated. In this perspective, the research in this dissertation moves from traditional probabilistic methods to assessing risk in context-specific situations.

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Appendix 1: Survey risk perception, attitudes and intended use of risk strategies

1 Which of the following answers best describes the situation on your farm:

- O Starting
- O Settled and growing
- O Settled and stable
- O Preparing for takeover
- O Preparing for pension

2 What part of your total family income is derived from farming and farm related activities?

0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

3 To what extend are you willing to take financial risks regarding your farm

Very unwilling				Very willing
1	2	3	4	5

4 To what extend do you agree with the following statements:

	Strongly disagree				Strongly agree
I am very happy with my profession	1	2	3	4	5
I am very happy with the income I receive from farming	1	2	3	4	5
It is important to me to be up to date about the newest technologies concerning my profession	1	2	3	4	5
I enjoy to experiment and I am willing to test new ideas	1	2	3	4	5
To be the owner of a farm should be considered as a long-term investment	1	2	3	4	5
In my opinion the trust between me and my business partners is more important than the profits I can make	1	2	3	4	5
If you are a farmers it is because you enjoy it, not for the profits you could make	1	2	3	4	5
To be able to manage my farm, I need substantial training and high education	1	2	3	4	5
I am farmer for quite some time now, and already gained all the experience I need	1	2	3	4	5
Farming is a profession, just like all the others	1	2	3	4	5
I regularly go to meetings to speak to, and learn from, other farmers	1	2	3	4	5
I prefer to work with my hands, rather than doing an office job	1	2	3	4	5
It is important to me to know that my heir will be able financially to take over the farm	1	2	3	4	5
There is no future for agriculture in Flanders	1	2	3	4	5
I worry about my future as farmer, but I do not know what else I could do	1	2	3	4	5
It is important for me that my company produces in a sustainable matter	1	2	3	4	5

5a How likely are the following events to happen on your farm?

	Low probability				High probability
Production loss due to (extreme) weather conditions	1	2	3	4	5
Production loss due to diseases and pests	1	2	3	4	5
Exceptionally low market prices	1	2	3	4	5
Exceptionally high cost prices	1	2	3	4	5
Too little revenues considering the costs over a long time period	1	2	3	4	5
Unexpected changes in regulation with negative impact on the farm	1	2	3	4	5
Limited access to land, or to high prices for land	1	2	3	4	5
Personal problems resulting in a negative impact on the company	1	2	3	4	5
Losing of (an important share of) the subsidies	1	2	3	4	5

5b What is the impact on your farm in case the following developments did occur?

	Low impact				High impact
Loss of production due to (extreme) weather conditions	1	2	3	4	5
Loss of production due to disease (epidemic)	1	2	3	4	5
Extraordinary low market prices	1	2	3	4	5
Extraordinary high cost prices	1	2	3	4	5
too little revenues considering the costs over a long time period	1	2	3	4	5
Unexpected changes in regulation with negative impact on the farm	1	2	3	4	5
Limited access to land, or to high prices for land	1	2	3	4	5
Personal problems resulting in a negative impact on the company	1	2	3	4	5
Cancellation of (an important share of) the subsidies	1	2	3	4	5

5c How much control do you have over the severity of the following events?

	Low control				High control
Loss of production due to (extreme) weather conditions	1	2	3	4	5
Loss of production due to disease (epidemic)	1	2	3	4	5
Extraordinary low market prices	1	2	3	4	5
Extraordinary high cost prices	1	2	3	4	5
too little revenues considering the costs over a long time period	1	2	3	4	5
Unexpected changes in regulation with negative impact on the farm	1	2	3	4	5
Limited access to land, or to high prices for land	1	2	3	4	5
Personal problems resulting in a negative impact on the company	1	2	3	4	5
Cancellation of (an important share of) the subsidies	1	2	3	4	5

6 What are the biggest risks concerning your farm?

Open question

7 To what extend do you agree with the following statements:

	Strongly disagree - Strongly agree
The biggest risk is not due to the price volatility, but rather due to ever decreasing margins (increasing costs and decreasing revenues)	1 - 2 - 3 - 4 - 5
I cannot influence most risks, the best way of coping with them is to optimise the work on my farm	1 - 2 - 3 - 4 - 5
By means of smart decisions I can decrease the risks on my farm	1 - 2 - 3 - 4 - 5
regulations and controls are responsible for a big share of the risks on my farm	1 - 2 - 3 - 4 - 5
I do not like to take risky decisions concerning my farm	1 - 2 - 3 - 4 - 5
I cannot cope very well with financial risk and uncertainty on my farm	1 - 2 - 3 - 4 - 5
I cannot afford to take risks on my farm	1 - 2 - 3 - 4 - 5
The farming profession knows many risks, that is the challenge	1 - 2 - 3 - 4 - 5
I can afford to experiment with new ideas, even if this means taking some risk	1 - 2 - 3 - 4 - 5
I am willing to take some risk if this means I possible obtain higher revenues	1 - 2 - 3 - 4 - 5
I cannot sleep at night if I did not do all to prevent risk on my farm as much as possible	1 - 2 - 3 - 4 - 5
I postpone investments until they really need to be done	1 - 2 - 3 - 4 - 5
I am usually very careful when it comes to financial decisions regarding my farm (like loans and investments)	1 - 2 - 3 - 4 - 5
I am not afraid to borrow money in order to do investments that can enhance profitability	1 - 2 - 3 - 4 - 5

8 To what extent would you, regarding your farm, consider the following strategies to protect yourself against financial uncertainty?

	Definitely - Definitely not
Keeping a financial buffer	1 - 2 - 3 - 4 - 5
Diversifying in production	1 - 2 - 3 - 4 - 5
Diversifying in on-farm income (tourism, farmers market)	1 - 2 - 3 - 4 - 5
Contracting prices etc.	1 - 2 - 3 - 4 - 5
Obtaining an off-farm income	1 - 2 - 3 - 4 - 5
Hedging on future markets	1 - 2 - 3 - 4 - 5
Investing in non-farm assets	1 - 2 - 3 - 4 - 5
Investing in technical optimization of farm	1 - 2 - 3 - 4 - 5
Investing in scale enlargement	1 - 2 - 3 - 4 - 5
Working harder in times of financial uncertainty	1 - 2 - 3 - 4 - 5
Postponing private purchases	1 - 2 - 3 - 4 - 5
Buying non-obligatory insurances	1 - 2 - 3 - 4 - 5
Avoiding big loans at the bank	1 - 2 - 3 - 4 - 5

9 With the intention to deal with risk and uncertainty, I took the following action (or I will take in the near future):

Open question

10 To what extend do you agree with the following statements:

	Strongly disagree - Strongly agree
When making strategic decisions, I actively gather information and consider these carefully in order to come to a considered decision	1 - 2 - 3 - 4 - 5
When making strategic decisions, I rely on my experience	1 - 2 - 3 - 4 - 5
When making strategic decisions, I trust the advice of my contacts, advisers, colleagues, etc.	1 - 2 - 3 - 4 - 5
I don't have to consider strategic decisions, I do as I always do	1 - 2 - 3 - 4 - 5
When making marketing decisions, I actively gather information and consider these carefully in order to come to a considered decision	1 - 2 - 3 - 4 - 5
When making marketing decisions, I rely on my experience	1 - 2 - 3 - 4 - 5
When making marketing decisions, I trust the advice of my contacts, advisers, colleagues, etc.	1 - 2 - 3 - 4 - 5
I don't have to consider marketing decisions, I do as I always do	1 - 2 - 3 - 4 - 5
When making daily decisions, I actively gather information and consider these carefully in order to come to a considered decision	1 - 2 - 3 - 4 - 5
When making daily decisions, I rely on my experience	1 - 2 - 3 - 4 - 5
When making daily decisions, I trust the advice of my contacts, advisers, colleagues, etc.	1 - 2 - 3 - 4 - 5
I don't have to consider daily decisions, I do as I always do	1 - 2 - 3 - 4 - 5

11 To what extend do you agree with the following statements:

	Strongly disagree - Strongly agree
I consider major decisions concerning my farm with the whole family and their opinion is important to me	1 - 2 - 3 - 4 - 5
I do not dare to make decisions that can jeopardize the family's income	1 - 2 - 3 - 4 - 5
I do not differ between private and company accounts	1 - 2 - 3 - 4 - 5
I use money from my private account to pay for loans for my farm	1 - 2 - 3 - 4 - 5
if I make less revenue of my farm than I postpone private purchases	1 - 2 - 3 - 4 - 5
Off-farm income is a necessity for the family's budget	1 - 2 - 3 - 4 - 5
The family's budget was very volatile last 5 years	1 - 2 - 3 - 4 - 5
I took considered financial risks the last five years at the company level	1 - 2 - 3 - 4 - 5
The income I received from my farm was very volatile in the last 5 years	1 - 2 - 3 - 4 - 5
I sometimes use money from my private account to pay debts for the farm	1 - 2 - 3 - 4 - 5

Appendix 2: Factorial survey, risk attitudes and intended risk behaviour in context

Q1. Indicate what is most applicable for you:

I avoid risk as much as I can I enjoy taking risk

1 2 3 4 5 6 7

Imagine you have won a prize of 100 euro in a lottery. You could take this price home immediately, or you could choose to bet your winnings to possible increase your winnings. If you choose to play you lose your 100 euro and you have the possibility to win more but you could also lose. The gamble involves a coin toss and your pay-out exceeds 100 euro for heads and is less than 100 euro for tails. You are asked to choose the exact pay-outs for heads and tails among the following options:

Your choice	Pay-out for heads	Pay-out for tails
A (No coin toss you keep 100 euro)	€ 100,-	
B	€ 150,-	€ 75,-
C	€ 200,-	€ 50,-
D	€ 250,-	€ 25,-
E	€ 300,-	€ 0,-

Q2.What choice has your preference?

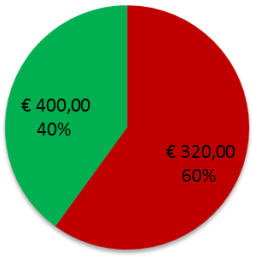
- A) I prefer to keep € 100,-
- B) I prefer to bet and possible win € 150,- if heads turns up, if tails turns up I still receive € 75,-
- C) I prefer to bet and possible win € 175,- if heads turns up, if tails turns up I still receive € 50,-
- D) I prefer to bet and possible win € 250,- if heads turns up, if tails turns up I still receive € 25,-
- E) I prefer to bet and possible win € 150,- if heads turns up, if tails turns up I receive nothing

Explanation

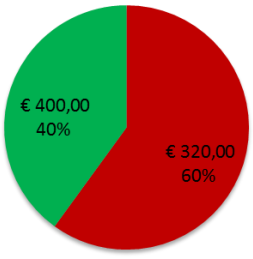
Below a pair of lotteries is shown repeatedly. You are asked to choose your preferred lottery out of the two. Each lottery consists of a probability of between 10% and 90% to win a high stake and the associated probability for the low stake. Within each pair of lotteries the chances stay the same, but the high and low stakes differ.

Example:

Lottery 1



Lottery 2

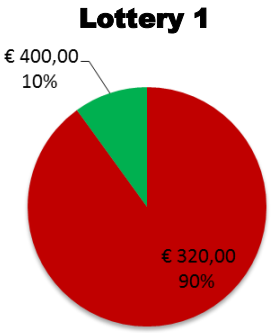


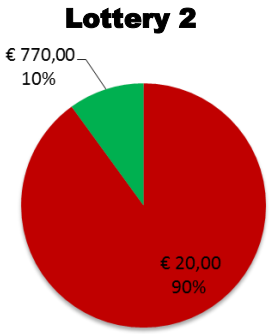
Lottery 1	
Probability	Pay-out
40%	€ 400,-
60%	€ 300,-

Lottery 2	
Probability	Pay-out
40%	€ 770,-
60%	€ 20,-

Q. Which of these two lotteries do you prefer?

- Lottery 1
- Lottery 2





Lottery 1		Lottery 2	
Probability	Pay-out	Probability	Pay-out
10%	€ 400,-	10%	€ 770,-
90%	€ 300,-	90%	€ 20,-

Q3. Which of these two lotteries do you prefer?

- Lottery 1
- Lottery 2

This question is repeated with an increase of 10% for the high stake option each repetition and until the respondent choses the "riskier" option (lottery 2) in three successive questions.

Q4a. To what extend are you willing to take production risks?
e.g. minimal pesticide use

Very unwilling						Very willing
1	2	3	4	5	6	7

Q4b. To what extend are you willing to take risk with innovative techniques and processes?
e.g. experimenting with high potential new crops that are not yet used by many colleague farmers.

Very unwilling						Very willing
1	2	3	4	5	6	7

Q4c. To what extend are you willing to take financial risks?
e.g. obtaining large loans

Very unwilling						Very willing
1	2	3	4	5	6	7

Q4d. To what extend are you willing to take risks regarding the marketing of your products?
e.g. abandoning the use of forward contracts

Very unwilling						Very willing
1	2	3	4	5	6	7

Q5. To what extend do you agree with the following statements?

	Totally disagree						Totally agree
In order to spread risk, I always make sure that I have different products to sell	1	2	3	4	5	6	7
I won't use a cultivar that is known to be more prone to disease, even if it has the potential for higher profits	1	2	3	4	5	6	7
In order to spread risk, I consciously chose for a high diversity in my production	1	2	3	4	5	6	7
I am constantly looking out for innovative techniques to sustain the rentability of my farm	1	2	3	4	5	6	7
In times of uncertainty I postpone investments	1	2	3	4	5	6	7
I always keep a buffer for times of hardship	1	2	3	4	5	6	7
I minimize the use of forward contracting in order to profit as much as possible from spot prices	1	2	3	4	5	6	7
I think I am more innovative than my colleague farmers	1	2	3	4	5	6	7
I prefer to make sure beforehand that I can sell all my products, even if this is jeopardizing the prices I could receive	1	2	3	4	5	6	7
I am not afraid to borrow money in order to make an investment that can increase profitability	1	2	3	4	5	6	7
I implement new technology even if other farmers in the area have not yet done so	1	2	3	4	5	6	7

Vignettes

Each vignette was repeated three times with a differing level for each dimension.

Vignette 1

Description

Kristof is a 47 year old farmer. He is contemplating changing his retailer. Kristof has a good relation with his current retailer. However, there is a new player at the market who is willing to pay Kristof an on average 15% higher price for his products. The prices would also be more volatile and therefore sometimes lower than the offer of his current retailer.

Kristof actively engaged in seeking information about this new retailer and he concludes that he indeed would on average get a higher price, but in years with low prices he would obtain a very low turnover. Moreover, his old vender would not easily take him back. Besides a on average higher turnover, Kristof would have to do a little extra administration for the new retailer.

Almost none of the other farmers in the area have yet changed to the new retailer. Kristof is receiving a small amount of income support. At this moment Willy has a small buffer. Willy is certain of having a successor.

Questions

1. Imagine that you are Kristoff, how likely would it be that you change to the new retailer?

Very unlikely			indifferent			Very likely
1	2	3	4	5	6	7

2. How big do you estimate the advantage of changing to the new retailer?

Very small						Very big
1	2	3	4	5	6	7

3. How big do you estimate the risk involved in changing to the new retailer?

Very little risk						Very big risk
1	2	3	4	5	6	7

4. How big do you estimate the control over the risk involved in changing to the new retailer?

Very little control						Very much control
1	2	3	4	5	6	7

Vignette 2

Description

Willy is a 47 year old fruit grower. Recently, Willy got the opportunity to get an insurance that protects him against production losses caused **by weather conditions**. Being insured he would receive a compensation for yield loss caused by weather conditions such as hail, drought, flood or storm.

Willy actively engaged in seeking information about this insurance. De government is subsidizing this insurance to a large extend. Willy calculated that he only pays between 5-10% of his average profit fort his insurance. The insurance complete covers big yield losses, hence bad years won't be that bad. Willy already had some negative experience with yield loss caused by extreme weather. His peers already took up the insurance.

Willy is receiving a substantial amount of income support. At this moment Willy has a big loan. Willy is not certain of having a successor.

Questions

1. Imagine that you are Willy, how likely would it be that you would get this insurance?

Very unlikely			indifferent			Very likely
1	2	3	4	5	6	7

2. How big do you estimate the necessity of such an insurance?

Very small						Very big
1	2	3	4	5	6	7

3. How big do you estimate the risk of yield loss due to **extreme weather conditions**?

Very little risk						Very big risk
1	2	3	4	5	6	7

4. How big do you estimate the control over possible yield loss **given extreme weather conditions**?

Very little control						Very much control
1	2	3	4	5	6	7

Vignette 3

Description

Luc is a 47 year old farmer. He is considering investing in the modernisation of his farm. This investment is needed in order to replace out-dated material.

The loan that is needed for his investment amounts 150.000 euro with a 15 year repayment term. Luc is eligible for obtaining a governmental investments subsidy. Luc knows the risk of the investment, it is not certain that the investment will pay off or even break even. He has consulted his family and the chance that Luc cannot fulfil his repayment terms is estimated to be 15%. (small but present). It mostly depends on possible bad years caused by disease at the farm.

Some farmers from the area did already do a similar investment. Luc is receiving no additional income support. At this moment Luc has a large loan. Luc is certain that he won't have a successor.

Questions

1. Imagine that you are Luc, would you borrow money for this investment?

Very unlikely			indifferent			Very likely
1	2	3	4	5	6	7

2. How big do you estimate the necessity of this investment?

Very small						Very big
1	2	3	4	5	6	7

3. How big do you estimate the risk of not being able to fulfil the payment terms?

Very little risk						Very big risk
1	2	3	4	5	6	7

4. How big do you estimate the control over the fulfilment of the payment terms for this loan?

Very little control						Very much control
1	2	3	4	5	6	7

Summary

Farming has always been a risky activity. Farmers invest in living capital, vulnerable to changing weather conditions, disease and epidemics. Besides, farmers often cope with small and decreasing profit margins, high capital costs and volatile market prices. In addition, farmers have to comply with strict and changing regulations to assure subsidies or avoid fines. In recent years, gradual long-term developments, such as climate change, globalisation and liberalisation of markets and changing policy regulation, have altered the risk for farmers. Moreover, farms have grown and became more specialized in the last decennia, which makes them more vulnerable to various risks. Successfully coping with risk is therefore of increasing pertinence for farmers.

The manner in which farmers make complex decisions in the face of uncertainty, using the various tools and strategies at hand, is principally studied in the field of agricultural economics. In particularly studies rooted in the framework of expected utility have dominated the risk behaviour literature. In this framework, risk behaviour is regarded as the process of maximizing risk preferences, or risk attitude, given the objectively measured or subjectively estimated risk. Even though these traditional studies brought major progress in the understanding of farmers' behaviour under risk, it is widely recognised that they fail to accurately predict actual behaviour. Moreover, the assumptions made by the expected utility theory approaches are known to be oversimplified and unrealistic. For example, risk attitude, that is, the innate propensity for avoiding or taking risk, is typically assumed to be a stable personality trait applicable to any risk, no matter the context. Furthermore, risk perception is not considered explicitly, but implicitly as the subjective probability of an objective risk. This dissertation offers an explorative investigation of risk closer to the actual understanding of risk by farmers. The focus is on farmers' risk perception, risk attitude, the decision context and the manner in which they jointly guide intended risk behaviour.

The studies presented in this dissertation are divided into two Parts. Part I, which follows rather traditional approach of risk research, presents results from a survey on general perceptions of risk, risk attitude and the intended use of risk management strategies of farmers in Flanders and consist of Chapter 2 until Chapter 4.

Chapter 2 presents the survey and its results. The main empirical finding is that farmers do not think of short-term volatilities as risks to be considered, but rather consider the long-term evolutions and stresses as risks. Examples of these long-term concerns are the margin between revenues and expenses, land availability, and policy issues. Moreover, the risk management strategies that are dominantly

studied in the literature, such as the use of insurances and forward contracts, are considered as least applicable by the farmers.

Chapter 3 presents and tests a conceptual model that takes both risk perception and risk attitude into account for explaining intended risk behaviour. The various risk management strategies that were considered (diversifying, externalizing risk management, optimizing farm operation, coping with risks once they appear, keeping a financial buffer for times of hardship, and obtaining an additional stable income), as well as the various perceived risks (price risk, production risk and institutional risk), are not specific to farming. Hence, the results of this study can therefore also be of interest to a wider public of risk researchers. The main findings showed that the perceptions of the major sources of (farm) risk were of minor importance compared to the general risk attitude in explaining the intention to apply different risk strategies. Moreover, the study shows that a higher aversion to risk is not necessarily linked with a higher intention to use risk strategies. Risk-averse farmers are more inclined to use reactive strategies, such as: working harder or postponing private spending, keeping a buffer for times of hardship, or obtaining an additional income. Farmers that are more willing to take and accept risks, prefer proactive strategies, such as: relying on external risk management tools (insurances and future markets), diversifying their production and sources of on-farm income, or optimising their business.

Chapter 4 investigates the impact of a number of known determinants of risk behaviour on the intended use of eleven different risk strategies. In this Chapter, the focus is on the effect of previously applied farm risk management strategies and income support. No evidence for 'crowding out' effects is found. Furthermore, previous risk management is found to be a poor predictor for the intention to use associated risk mitigation strategies in the future. Moreover it is found that, regardless of the large number of determinants included in the regression analysis, the total variance explained by the intended use of the various risk strategies is quite low. This indicates that there might be other determinants, more relevant to the farmer or the farm situation, that could be better predictors for farm management. Examples of such determinants, like the decision context, are described in Part II.

Part II, which moves away from the traditional approach taken in Part I, investigates the assumptions of some quantitative risk approaches and focuses on the question of how context shapes decision making under risk.

Chapter 5 of this dissertation investigates the actual perception of risk by farmers. It starts from the observation that assumptions about risks taken in the traditional approaches are barely investigated. To investigate farmers' actual risk perception and to avoid adopting prior assumptions, the study takes a grounded theory approach. This resulted in the understanding that risk is perceived by farmers as a network that connects different sources of uncertainty to various consequences that matter, rather than as a chain of events. Cognitive mapping is presented as a method capable of elucidating and presenting risk networks. This offers a novel way

to contemplate risk perception and better approximates the actual understanding of risk by farmers compared to the traditional approaches that take a quantitative stance towards risk perception.

In Chapter 6, risk attitude is considered. This Chapter investigates to what extend risk attitude measures, as measured by various economic and psychological methods, are valid in more realistic settings. Furthermore, it aims to investigate the influence of contextual variables on risk behaviour. The main empirical findings from this Chapter are threefold. First, it is established that risk attitude, as measured by common risk attitude assessment methods from economics and psychology, does not predict risk taking for realistic risky choices. Second, it is found that context (such as the relations with suppliers, behaviour of collegial farmers, or having a successor) plays an important role in the choice to take or avoid risk, in a realistic farm management setting. Finally, it is found that the perception of the consequences of taking risk is of major influence in the decision to take or avoid risk.

In summary, this dissertation describes the gap between theoretical conceptions of risk and risk behaviour on the one hand, and the conceptions of risk and risk behaviour of individual decision makers on the other. From this gap, a need arises to pursue new ways of considering risk, as well as the methods to study these. These methods should take risk perception more explicitly in consideration, as well as a more context specific risk attitude. Furthermore, these new methods should focus on the risks that are important to farmers, such as the long-term random events and catastrophic risk, rather than merely the risks for which quantitative data is available. New methods should also allow for risk assessments in which multiple goals and sources of uncertainty interact, rather than focus merely on the maximisation of utility. Since farmers are often not able to quantify a range of risks, new methods should allow for non-parametric risk to be analysed. Finally, given the importance of contextual variables in predicting risk behaviour, new methods should be able to assess risk in their decision context. This dissertation offers a first exploration into new ways to conceptualise risk and provides innovative methods to study them.

Samenvatting

Landbouw is een risicovolle onderneming. Landbouwers investeren in levend kapitaal, dat kwetsbaar is voor extreme weersomstandigheden, ziektes en epidemieën. Bovendien worden landbouwers meer en meer geconfronteerd met steeds kleiner wordende winstmarges, hoge investeringskosten en volatiele marktprijzen. Daarnaast zijn er incidenteel aanpassingen in het landbouw beleid, die er toe leiden dat de regelgeving en subsidies voor landbouwers onberekenbaar en onzeker zijn. In de laatste jaren, is het risico op het landbouwbedrijf gewijzigd als gevolg van geleidelijke langdurige ontwikkelingen, zoals klimaatsverandering, toenemende globalisering en liberalisering van markten en een veranderend Europees landbouwbeleid. Bovendien zijn veel landbouwbedrijven gegroeid en gespecialiseerd in de laatste decennia, waardoor ze meer vatbaar zijn voor verscheidende risico's. Het succesvol kunnen omgaan met risico is dan ook één van de grootste uitdagingen op het landbouwbedrijf geworden.

De wijze waarop landbouwers met risico omgaan, wordt onder andere bestudeerd in het vakgebied van de landbouweconomie. In het bijzonder wordt het risico-onderzoek gedomineerd door studies die zich baseren op de verwachte-nutshypothese. In dit kader wordt risicogedrag beschouwd als het proces van het maximaliseren van de risicohouding, gegeven het objectief gemeten risico, of het subjectief geschatte risico. Hoewel het onderzoek binnen de verwachte-nutstheorieën tot heel wat inzichten heeft geleid, moet worden vastgesteld dat de studies in dit kader slechts een beperkte voorspellende waarde hebben over het daadwerkelijke risicogedrag. Bovendien zijn de uitgangspunten van de verwachte-nutshypothese vaak te sterk vereenvoudigd en onrealistisch. Zo wordt de risicohouding, oftewel de neiging om risico te vermijden of juist aan te gaan, verondersteld stabiel te zijn, ongeacht de context van het risico. Verder wordt de perceptie van risico niet expliciet overwogen, maar slechts impliciet als de subjectieve toegerekende kans dat een risico zich voordoet. Dit proefschrift bundelt exploratieve studies naar het daadwerkelijke beoogde risicogedrag van landbouwers. De focus in het gepresenteerde onderzoek is op de perceptie van risico, de houding ten opzichte van risico, de beslissingscontext en hoe die samen het risico gedrag sturen.

Dit proefschrift is inhoudelijk gestructureerd in twee delen. De studies gepresenteerd in Deel I zijn gebaseerd op een enquête over risicoperceptie, risicohouding en het beoogde gebruik van strategieën voor risicomanagement door landbouwers in Vlaanderen. Deze studies volgen een traditionele aanpak ten opzichte van risico. Deel I bestaat uit Hoofdstuk 2 tot en met Hoofdstuk 4.

In Hoofdstuk 2 worden de resultaten van de enquête gepresenteerd. De voornaamste conclusie uit deze enquête is het feit dat landbouwers zich vooral

zorgen maken over de lange termijn evolutie van de marge tussen kosten en opbrengsten, grondbeschikbaarheid en beleid en niet zozeer over kortere termijn volatiliteiten van prijzen of oogsten. Bovendien worden de strategieën voor risicomanagement die het meest worden onderzocht in de literatuur (zoals, het gebruik van verzekeringen en contracten), door de landbouwers beoordeeld als het minst relevant voor het eigen bedrijf.

In Hoofdstuk 3 wordt een conceptueel model gepresenteerd en getest. Dit model verklaart het beoogde gebruik van strategieën voor risicomanagement aan de hand van de percepties van de voornaamste risico's en de algemene houding t.o.v. risico. De onderzochte risicopercepties (prijs risico, productie risico en institutioneel risico) en de strategieën voor risicomanagement (diversificatie, extern risicomanagement, optimalisatie van het productieproces, ex-post omgaan met het risico, aanhouden van een buffer, en het verkrijgen van een extra inkomen) zijn niet specifiek voor de landbouw. Daarmee zijn de resultaten van dit onderzoek ook bruikbaar voor een breder publiek van risico-onderzoekers. Er wordt geen significant verband gevonden tussen de perceptie van de algemene risico's en de intentie om de strategieën voor risicomanagement toe te passen. Er wordt wel een significant verband gevonden tussen risicohouding en de intentie om deze strategieën toe te passen. Bovendien is risicohouding niet noodzakelijk negatief gerelateerd aan het gebruik van de strategieën voor risicomanagement. In andere woorden, een negatieve houding t.o.v. risico leidt niet altijd tot een intensiever gebruik van deze strategieën. Strategieën voor risico averse landbouwers (zoals harder werken, sparen op het gezinsbudget, het bijhouden van een buffer, of het verkrijgen van een extra inkomen) kunnen zo worden onderscheiden van strategieën voor landbouwers die risico minnend zijn (zoals het gebruik van externe instrumenten voor risicobeheer, de diversificatie van de productie, of het optimaliseren van de productie op het bedrijf).

In Hoofdstuk 4 wordt dieper ingegaan op de factoren die bepalend zijn voor het beoogde gebruik van de verschillende strategieën voor risicomanagement. De onderzochte factoren zijn gebaseerd op een literatuurstudie en de focus ligt vooral op het effect van de in het verleden gebruikte strategieën voor risicobeheer en inkomenssteun. Zowel de in het verleden toegepaste strategieën voor risicobeheer als de ontvangen inkomenssteun blijken geen goede voorspellers voor het huidige gebruik van strategieën voor risicomanagement. Tevens, blijkt dat de voorspellende waarde van alle onderzochte factoren erg laag is. Dit wijst erop dat andere, niet zo vaak onderzochte factoren, van groter belang kunnen zijn in de afweging van een landbouwer om de strategieën voor risicomanagement toe te passen op het eigen bedrijf. Voorbeelden van dergelijke factoren, zoals de beslissingscontext, worden beschreven in Deel II.

In Deel II van dit proefschrift, wordt er afstand genomen van de traditionele methode en van de aannames over risico die deze methoden veronderstellen. Bovendien wordt het belang van de beslissingscontext nader onderzocht.

In Hoofdstuk 5 wordt onderzocht hoe landbouwers risico daadwerkelijk percipiëren. Het onderzoek vertrekt vanuit de vaststelling dat aannames over risico die worden

verondersteld in de traditionele methoden voor risico-onderzoek, zelden worden onderzocht. Om deze aannames te onderzoeken en tegelijkertijd risico zoals daadwerkelijk gepercipieerd door landbouwers te verkennen, wordt een *grounded theory* benadering toegepast. De belangrijkste bevinding is dat risico wordt gepercipieerd als een netwerk dat verschillende bronnen van onzekerheid verbindt met diverse gepercipieerde consequenties. *Cognitive mapping* biedt een innovatieve manier om deze netwerken te achterhalen en zo de risicoperceptie van landbouwers te verhelderen. Deze netwerken staan dichterbij de daadwerkelijke perceptie van risico door landbouwers dan de representatie door de kwantitatieve methodes.

In Hoofdstuk 6 wordt de risicohouding van landbouwers onderzocht. Het onderzoeksdoel in dit hoofdstuk is tweeledig: Ten eerste wordt de validiteit van verschillende meetmethode voor risicohouding onderzocht. Ten tweede wordt de invloed van de beslissingscontext op het nemen van risicovolle beslissingen onderzocht. Er wordt vastgesteld dat de verschillende metingen voor risicohouding geen goed beeld geven van de daadwerkelijke houding t.o.v. risico in een meer realistische context. Bovendien wordt er geconstateerd dat de context van een beslissing een belangrijke rol speelt in de afweging van de landbouwer om risico aan te gaan dan wel te vermijden, zelfs al heeft deze context geen invloed op het risico per se. Ten slotte, wordt er in Hoofdstuk 6 vastgesteld dat de perceptie over het risico dat gepaard gaat met een risicovolle beslissing, van grote invloed is op de intentie om dit risico te nemen of te vermijden.

Samengevat beschrijft dit proefschrift een hiaat tussen hoe risico in de landbouw wordt bestudeerd en hoe risico wordt beleefd door landbouwers. Daaruit volgt een behoefte aan nieuwe manieren om risico te beschouwen en nieuwe methoden, of alternatief gebruik van bestaande methoden, om risico te bestuderen. Deze nieuwe methoden moeten zowel explicieter de perceptie van landbouwers als een meer specifieke risicohouding meenemen in hun verklaring van risicogedrag. Daarnaast moeten nieuwe methoden meer gericht zijn op de risico's die belangrijk zijn voor de boeren, zoals lange termijn risico, willekeurige gebeurtenissen en catastrofaal risico. Deze nieuwe methoden voor risicoanalyse moeten ook plaats bieden aan het feit dat landbouwers meerdere en soms conflicterende doelen nastreven en het feit dat verschillende risico’s met elkaar verbonden zijn. Bovendien moeten er meer kwalitatieve methodes komen, gezien de vaststelling dat landbouwers vaak moeite hebben met het kwantificeren van risico. Ten slotte, moeten nieuwe methodes meer aandacht schenken aan de context waarin een beslissing over risico genomen wordt, gezien het belang van contextuele variabelen in het voorspellen van risicogedrag. Dit proefschrift biedt een eerste verkenning naar dergelijke nieuwe manieren om de risico's te conceptualiseren en biedt methoden om zowel risicoperceptie als de invloed van risicocontext op het intentioneel risicogedrag te bestuderen.

Curriculum Vitae

Frankwin Hugo van Winsen

Education

Doctor of Philosophy in Applied Biological Sciences, Ghent University, Ghent, Belgium, 2010-2014
- Doctoral dissertation on determinants of farmer's risk behaviour
- Doctoral training programme in 'Bioscience Engineering' at Ghent University

Master of Science in Sustainable Development, Utrecht University, Utrecht, the Netherlands, 2007-2009
- Master thesis on non-linear vegetation patterns in arid ecosystems
- Specialisation in 'Land Use, Environment and Biodiversity'

Bachelor of Science in Biology, Utrecht University, Utrecht, the Netherlands, 2003-2006
- Erasmus exchange student at Lund University (Sweden), 2005-2006

Selected Publications

7.7.1 A1: Articles published in international peer reviewed scientific journals indexed in Web of Science:

van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., Wauters, E., 2013. Cognitive mapping: A method to elucidate and present farmers' risk perception. *Agricultural Systems* 122, 42–52

van Winsen, F., de Mey, Y., Lauwers, L., Van Passel, S., Vancauteren, M., Wauters, E., 2014. Determinants of risk behaviour: effects of perceived risks and risk attitude on farmer's adoption of risk management strategies. *Journal of Risk Research. In Press*

Wauters, E., van Winsen, F., de Mey, Y., Lauwers, L., 2014. Risk perception, attitudes towards risk and risk management: evidence and implications. *Agricultural Economics Czech (Zemědělská ekonomika)* 60, 389–405

7.7.2 A2: I Articles published in international peer reviewed scientific journals not indexed in Web of Science:

de Mey, Y., van Winsen, F., Van Passel, S., Vancauteren, M., Lauwers, L., Wauters, E., 2014. Farm-level evidence on risk balancing in the EU-15. *Agricultural Finace Review* 74, 17–37.

7.7.3 Submitted articles under review

de Mey, Y., van Winsen, F., Van Passel, S., Vancauteren, M., Lauwers, L., Wauters, E., 2014. Risk management versus entrepreneurship: the dual direction of risk balancing.

Wauters, E., van Winsen, F., de Mey, Y., Van Passel, S., Vancauteren, M., Lauwers, L., 2014. The foregone risk premium: a practical indicator for the comparison of risk-return profiles in agriculture in the presence of data scarcity.

7.7.4 C1: Congress contributions:

van Winsen, F., 2014. Determinants of Farmers' Intention to Use Risk Strategies, *The 14th EAAE Congress, Agri -Food and Rural Innovations for Heahthier Societies*, 26- 29 August, Ljubljana, Slovenia.

van Winsen, F., 2013. Exploring the determinants of farmers' risk behaviour: a survey approach, *The 22nd SRA-E Conference*, 17-19 June, Trondheim, Norway

van Winsen, F., 2013. Combining risk perception and risk attitude: A comprehensive individual risk behaviour model, *The 22nd SRA-E Conference*, 17-19 June, Trondheim, Norway

van Winsen, F., Wauters, E., Lauwers, L., de Mey, Y. , Van Passel, S., Vancauteren, M., 2013. A typology of farmers ' risk coping strategies, *The 5th EAAE PhD Workshop, Organized by the Belgian Association of Agricultural Economists*, 29-31 May, Leuven, Belgium.

van Winsen, F., 2012. An adapted influence diagram of risk conception of Flemish farmers, *The 14th BVLE/ABER PhD Symposium*, April 18, Brussels, Belgium

van Winsen, F., Wauters, E., Lauwers, L., de Mey, Y. , Van Passel, S., Vancauteren, M., 2011. Combining risk perception and risk attitude: A comprehensive individual risk behaviour model, *The 13th EAAE Congress Change and Uncertainty*, 30 August – 2 September, Zurich, Switzerland

van Winsen, F., Wauters, E., Lauwers, L., de Mey, Y. , Van Passel, S., Vancauteren, M., 2011. Increase in milk price volatility experienced by Flemish dairy farmers: A change in risk profile, *The 13th EAAE Congress Change and Uncertainty*, 30 August – 2 September, Zurich, Switzerland

van Winsen, F., Wauters, E., Lauwers, L., de Mey, Y. , Van Passel, S., Vancauteren, M., 2011. Increase in milk price volatility experienced by Flemish dairy farmers: A change in risk profile, *The 13th BVLE/ABER PhD Symposium*, 27 April, Brussels, Belgium

van Winsen, F., Wauters, E., Lauwers, L., van Passel, S., 2010. Combining risk perception and risk attitude: Integrating quantitative and qualitative methods for building a comprehensive individual risk behaviour model, *Risk Elicitation and Stated Preference Methods for Climate Change Research*, 21-22 October, Trento, Italy